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THE GROSS EARNINGS OF 151 RAILWAYS for the month of September, according to statistics collected by the *Financial Chronicle*, are $43,381,520, as compared with $40,407,531 for the same month of 1889, an increase of 7.36%. The increase is quite general in all parts of the country, and is especially significant of the prosperous condition of the railway transportation business, since the September earnings of 1889 showed a large increase over the same month of the previous year. One of the most noticeable things in the detailed list is the strikingly favorable results shown by Southern roads. Of 46 roads reporting from this section only 3 report decreases.

A SCHEME FOR PROTECTING RAILWAYS FROM FLYING SAND is suggested by Prof. SCHUBLER, a German botanist. He proposes to use the roots of the plant *triticum repens L.* The roots are cut in a machine into lengths of 20 centimetres, mixed with a little earth, clay and water sufficient to form a dough-like mass. This is spread with a spade over the sand, and in a couple of weeks it begins to spread and bind the sand.

A RAILROAD CHURCH, built at Tiflis, in the shop of the Batoum-Baku Railway, is significant of Russian advance in Asiatic territory. The car-body is surmounted at one end by a cross and at the other by a low belfry and chimes. It seats 70 people, and is intended for the benefit of railway employés.

THE VESTIBULE CAR PATENT is now the sole property of GEORGE M. PULLMAN and his company. The U. S. Circuit Court, at Boston, has rendered a decision in favor of the Pullman patent of 1889, not only for details, but for purpose. This decision is substantially a verdict against the Wagner Co.

THE WORST ACCIDENT OF THE WEEK, all things considered, was perhaps a disastrous triple freight collision just in front of Cresson station, on the Pennsylvania R. R., Oct. 11, by which only one man was killed and one seriously injured, but two engines and 20 cars badly smashed. A few other accidents have shown a larger list of injuries, but none of them are notable ones. There are three parallel tracks at Cresson, which are, in succession, east-bound, west-bound and a long siding. A west-bound freight train took the siding and did some work on it, taking it from a middle cross-over switch in front of the station, the points for which it left wrong. It was just pulling up toward the west end of the siding when a following west-bound freight train dashed at full speed through the misplaced switch, and struck the first train near the middle, piling cars all over all three tracks. Almost at the same instant a third east-bound freight came along at full speed and ran into the wreck. The smash was a very bad one, and the main lines were blocked nearly 10 hours. In England such an accident could not occur, because there the use of mechanical safeguards is universal.

BRIDGE DISASTERS have been few. A covered wooden bridge 12 miles north of Selma, Ala., on the East Tennessee, Va. & Ga. R. R., was destroyed by fire Oct. 5. Two so-called bridges (possibly trestles) on the Pittsburg division of the Baltimore & Ohio washed out, and an unfinished highway bridge near Webster Springs, W. Va., fell, precipitating six persons into the Eld River, 40 ft. below, two of whom were killed and the rest injured.

THE ANNAPOLIS ARMOR PLATE TESTS have been completed by the removal of the plates from the backing and the examination of the rear of the plates. The result was as follows: The four cracks in the all-steel Creusot plate, radiating from the center 8-in. shot, were not continuous on the back, as supposed, and the plate still had strength enough to support itself. The back of the Creusot nickel-steel did not show a crack, except where the metal was bulged out by the points of the projectiles. This plate was still apparently perfect, except at the five spots actually struck by the projectiles. The back of the Cammell plate was also uncracked, except immediately around the five more or less ragged holes where the shots had cracked through it.

The backing behind the two Creusot plates was practically uninjured, except that there was a bruised dent in the wood at the point over which each shot had struck, showing where the point of the projectiles and the bulged-out metal had been driven against the wood with great force. The backing of the all-steel plate had rather the better appearance of the two. The backing of the Cammell compound plate was badly wrecked. Two great, ragged, splintered holes, clear through the 36 ins. of oak, marked the paths of the last 6-in. projectile and the 8-in. projectile, while in each of the three remaining 6-in.-shot holes a projectile is still buried in a mass of splinters.

BIDS FOR HEAVY GUNS have been called for by the War Department, until Dec. 3, as follows: twenty-five 8-in., fifty 10-in. and twenty-five 12-in. steel guns and ammunition for the test. All of these guns are to be of American manufacture, and the advertisements provide that one-fourth of these guns shall be made on the Pacific coast.

WOODITE OR CELLULOSE PACKING is provided for in the specifications for our last new war ships. These are water-excluding materials, to be packed along the sides and under the slopes of the 3-in. protective decks. Cellulose is made of the ground fibre of the cocoanut husk, and has the property of at once swelling up when wet, and closing any opening made through it. In French experiments the hole made by a 10-in. shot only admitted 3½ galls. of water per minute, and soon closed entirely. One cubic foot of it weighs only 7½ lbs., and as prepared its cost is about $1 per cu. ft. Woodite is not so well known, but is said to have a base of India rubber. The bouyant variety has the appearance of cork chips, weighs about 14 lbs. per cu. ft., and costs about 66 cts. per cu. ft. Elastic woodite, another variety, weighs 64 lbs. per cu. ft., but it has wonderful swelling properties.

THE HARBOR DEFENCE RAM, designed by Rear Admiral AMMEN with details completed by the U. S. Navy department, will be cigar-shaped, 243 ft. long over all, 43½ ft. in extreme width; draught amidships 15 ft.; displacement, 2,050 tons; indicated horse-power, 4,800; speed 17 knots. The vessel is designed upon the longitudinal bracket system with an inner shell extending from the collision bulkhead to the the stern. The two shells are divided by the longitudinal girders and armor shelves into 62 water-tight compartments with 30 more in the deck covering. The ram will be removable and made of wrought steel. The heaviest deck armor is 6 ins. but the only projections above this deck will be the conning tower, smoke stack, ventilators and hatch combings. The vessel is to be submerged to fighting trim by means of 14 Kingston valves placed in the double bottom. Blowers would be used to exhaust the foul air in the ship. There will be no guns, as the vessel will depend entirely upon ramming for hre offensive powers.

THE NEW TOWER BRIDGE over the Thames in London is progressing satisfactorily. Including approaches the bridge will be 2,640 ft. long. The two river piers, requiring the laying of about 80,000 tons of stone, are nearly completed. The north towers to be 275 ft. high, are well under way, and the false-works for the two side spans are in position. In the construction of this bridge there will be required 31,000,000 brick, 19,500 tons of cement and 70,500 cu. yds. of concrete, and 15,000 tons of iron and steel. The bridge will be finished by the end of 1892. Mr. WOLFE BARRY, C.E., is the engineer, and Messrs. Arrol & Co., the contractors.

THE COULS BRIDGE AT PRAGUE, which has withstood the floods of over five centuries, since 1357, lost another arch Oct. 13, severely injuring six persons. The hottest fighting of the Battle of the Prague, in 1744, took place on the bridge. Of its 16 arches the central arch fell Sept. 3, and two others the day after, with large loss of life, as we noted at the time. A fourth arch has now gone. The cause is undercutting of foundations. The structure was 150 years building.

THE BROOKLYN BRIDGE REPORT for September shows 3,436,825 passengers using the bridge in that time, the daily average being 114,561. The railway carried 3,165,233 of this number. The receipts for this month were $95,072.91.

THE NIAGARA FALLS WATER-POWER TUNNEL is now well under way, at two shafts and at the mouth near the new suspension bridge. At the latter point an inclined railway for construction use will be built. Both night and day shifts will shortly be put on.

THE ERIE & OHIO SHIP CANAL project, from Pittsburg to Cleveland, is exciting deep interest in Pittsburg and the Lake cities. It is stated that a single firm, Carnegie, Phipps & Co., will ship 1,500,000 tons of ore from the Lakes to Pittsburg this year, while 6,000,000 tons of coal are shipped back from Pittsburg, largely to Chicago by rail. The Pennsylvania Canal Commission is now certain to report to the Legislature favorably, it is said. An effort will be made to obtain Federal aid, and not unreasonably, it would seem. To show the commerce affected, 12,000 vessels entered Chicago last year, and over 40,000 passed through the Detroit River.

THE BUSK-IVANHOE TUNNEL approaches have been completed at both ends and about 100 ft. of the heading from the east end has been driven. Work at the west end has just commenced. About 300 men are employed and at present about 5 ft. per day is being excavated. The material penetrated is solid granite rock.

THE PENNSYLVANIA SHIP CANAL SURVEYS are practically completed, and the Commission will ask the State to begin construction. They report the scheme feasible, and favor a route to Lake Erie by way of the Beaver River. The figures are not yet given as to detail and estimates.

THE PARIS-ROUEN SHIP CANAL PROJECT has progressed sufficiently to have all the papers and plans connected with it submitted to public inspection at the Hotel de Ville, in Paris, until Nov. 1. The proposed canal, from Rouen to Paris, would be 108 miles long and have a depth of 19.7 ft. The cost is estimated at $27,000,000.

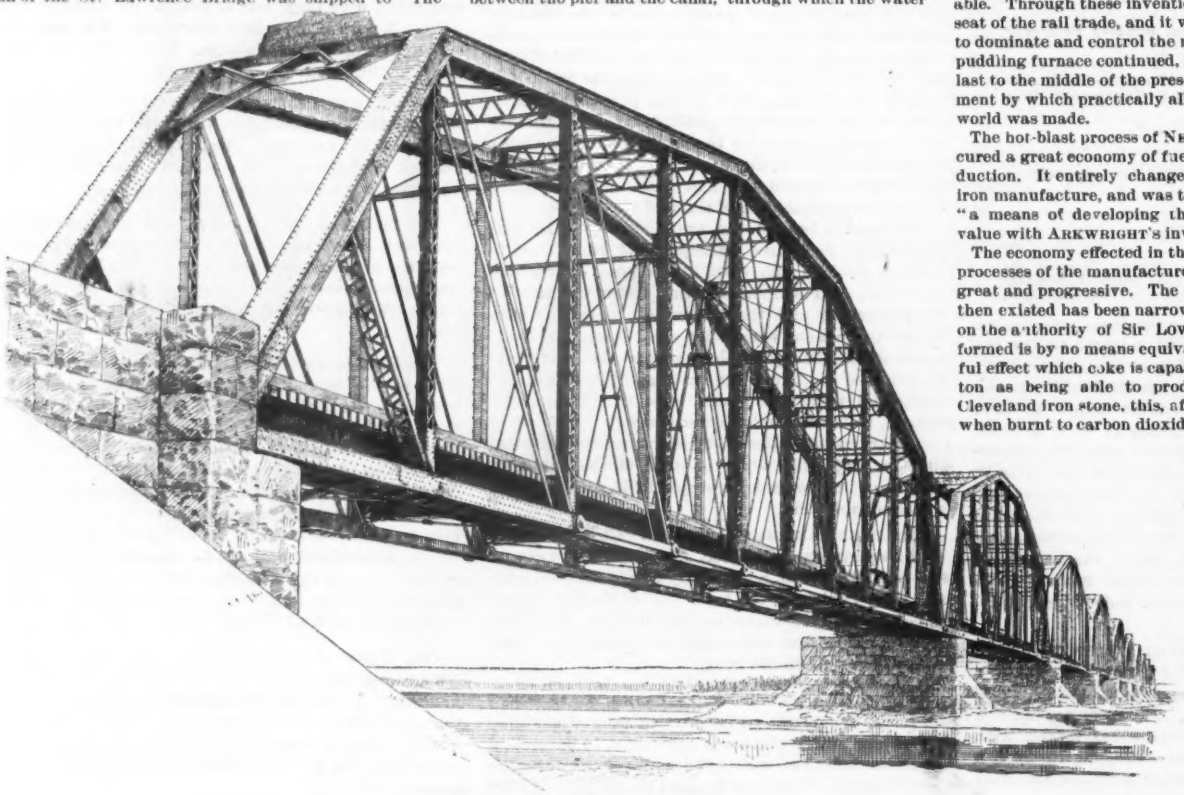
NICARAGUA CANAL REPORTS, to Oct. 13, say that 1,600 men are now at work on this canal and railway; the latter has been extended four miles inland. One steam dredger has arrived from Colon, and another is daily expected. The depth of water in the cut into the lagoon has been increased to 8 ft., and the dredger is now widening the channel, which will be deepened when the other dredger arrives.

A JERSEY SHIP CANAL is being discussed in the newspapers of that State. No details of the proposed route are given other than that it is to pass diagonally across the State from Mt. Holly, near the Delaware River, to the Atlantic Ocean, near Shark River. The length to be excavated would be about 60 miles, through a flat country, with little or no rock. An alternate route would reach the ocean at Toms River.

The Sault Ste. Marie Bridge.

We illustrate herewith the bridge across the Sault Ste. Marie connecting the Canadian Pacific Ry. with the Duluth, South Shore & Atlantic and Minneapolis, St. Paul & Sault Ste. Marie Rys. The following description of the structure we extract from a paper by G. H. MASSY, in the proceedings of the Canadian Society of Civil Engineers:

In the autumn of 1885 it was decided by the Sault Ste. Marie Bridge Co. to build a bridge across the Ste. Marie River at the "Soo," and a party was organized to make the preliminary surveys, from the results of which it was decided to construct the bridge at the upper end of the Ste. Marie's rapids, where the smooth water of Lake Superior commences to break away over the rocky bed of the river. The bottom is of smooth, level standstone of the Potsdam formation, perfectly bare of gravel or debris, with the exception of Pier No. 1, where a considerable deposit was formed. In the winter of 1886-7 the contract for the construction was awarded to R. G. REID, who the year before had completed the bridge over the St. Lawrence River at Lachine, P. Q., for the Canadian Pacific Ry. Work began in May, 1887. Most of the plant used in the construction of the St. Lawrence Bridge was shipped to "The Soo," and comprised 2 tugs, 22 scows, 3 of which were furnished with steam derricks, 2 pumps, 6 large anchors, 2 clam shell dredges, and other but less important implements used on such work.



THE SAULT STE. MARIE BRIDGE.

The depth of the water on the site of the bridge varied from 2 to 12 ft. Although the extreme rise of the river, except after a westerly gale, does not exceed 2½ ft., it is at any time liable to 1½ ft. rise in less than an hour, due to some wave motion of the Great Lakes. The swiftest current is where the water is deepest, towards the Canadian side, and attains a velocity of 9 miles per hour. The shallowness of the water rendering it impossible to bring the tugs within less than 300 ft. of the piers, the scows and caissons had to be lowered down by ropes.

The plan of foundation is similar to the St. Lawrence Bridge, namely, caissons with water-tight sides of 12 × 12 in. timber, without any bottom, the sides scribed to fit the rock. The caissons were so designed as to allow a space of 4 ft. 6 ins. between the timber and the sides of the piers. A curtain of canvas was nailed round the inside of the caisson to check any current while depositing the concrete.

The concrete was formed of sand and Portland cement in equal quantities, to which was added as much broken stone as the mortar thus made would take. This concrete was deposited by the same boxes as were used at the St. Lawrence Bridge. The depth of concrete was never less than half the depth of the water, with a minimum depth of 2 ft. The second day after the concrete was deposited the caisson was pumped dry, the bottom leveled, and masonry commenced. In building with timber caissons and concrete bottoms, the depth of the latter should not be less than ⅓ the depth of the water, with a minimum depth of 2 ft. Less concrete than this is apt to cause troublesome leaks, and the concrete box should hold 2 cu. yds. The masonry of the small bridge on the Canadian side was commenced June 9, and the north abutment of the main bridge on June 2; but no masonry was laid in the river piers until Aug. 9, as much time was lost in negotiating with the United States Government as to duty on plant and material, etc. The last of the masonry of the main bridge was laid Oct. 7.

The work proceeded rapidly and smoothly without serious mishaps or accidents of any kind, the experience gained on the St. Lawrence Bridge by the men employed proving of great service. No. 1 pier was the most tedious, as a large quantity of gravel had to be dredged off by means of a large rake attached to a long handle, operated from scows anchored over the foundation, any remaining gravel being cleared off after the caisson had been placed. The most troublesome and costly foundation was the center pier for the draw span. This had to be carried down 22 ft. below water level through seamy rock in anticipation of the enlargement of the canal at some future date. The pier was circular, with a diameter of 30 ft; the excavation being several feet wider, left only about 20 ft. of rock between the pier and the canal, through which the water poured like a river, requiring the constant use of two large rotary wrecking pumps until the masonry reached the water level. The stone used for the pivot pier and for the pier at Canal St. was Ohio sandstone, the remainder being white limestone from the Owen Sound quarries. The general plan of piers and abutments is similar to those of the St. Lawrence Bridge, the piers of the main bridge all being 10 ft. wide on top.

The following is a brief outline of the bridge: Commencing on the Canadian side the approach to the bridge is a timber trestle 1,500 ft. in length, with two spans of iron crossing a small branch of the river; then comes the main bridge, consisting of 10 spans of 242 ft. each; all pin-connected through girders, then 400 ft. of embankment which reaches the north abutment of the draw span over the Ste. Marie Canal. This span has a total length of 396 ft., crossing the canal at an angle of about 60°, then comes another embankment of 230 ft. and a plate girder over Canal St. reaches the southerly limit of the Bridge Co.'s property.

Sir James Kitson's Address at Pittsburg.

On the arrival of the Am. Inst. of Mining Engineers and their British and German guests at Pittsburg, Mr. RICKETSON delivered an address of welcome and Sir JAMES KITSON replied for the British Iron and Steel Institute. Omitting his graceful introductory and his complimentary remarks concerning the American Institute and the iron masters of Pittsburg, the substance of his address may be condensed as follows:

Our Institute is not exclusively British; in truth, it is cosmopolitan, having enrolled on its list of members distinguished metallurgists of the United States, Germany, France, Sweden and Russia. The birthplace and the headquarters of the Institute are in England. It will, therefore, I hope not be considered in any way presumptuous if I ask you for one moment to consider how much the world is indebted to my native land for the vast benefits which mankind has received from its engineers and its manufacturers of iron and steel.

The inventions of WATT and TREVETHICK; the development of the steam engine, with all its consequential powers; the construction of the locomotive, and the creation of the railroad by STEPHENSON, are directly the work of England and of Englishmen. These discoveries have made that system of railways and service of ocean steamers which have brought the nations of the earth together, have made new lands accessible and of service to man, and are destined in due time to diffuse knowledge and civilization into every quarter of this globe

The puddling furnaces of CORT, and his method of rolling the puddled blooms in grooved rolls, produced wrought iron in quantities and at a cost hitherto unattainable. Through these inventions South Wales became the seat of the rail trade, and it was enabled for many years to dominate and control the rail trade of the world. The puddling furnace continued, from the latter part of the last to the middle of the present century, to be the instrument by which practically all the malleable iron in the world was made.

The hot-blast process of NEILSON, patented in 1828, secured a great economy of fuel and a large increase of production. It entirely changed the condition of the pig-iron manufacture, and was truly ranked by MUSHET as "a means of developing the national wealth of equal value with ARKWRIGHT'S invention of cotton spinning."

The economy effected in the use of coal in the various processes of the manufacture of iron and steel has been great and progressive. The margin for economy which then existed has been narrowed. But still, as you know on the authority of Sir LOWTHIAN BELL, the duty performed is by no means equivalent to the whole of the useful effect which coke is capable of affording. "Taking a ton as being able to produce 20 cwt. of pig iron from Cleveland iron stone, this, after an allowance for ash, etc., when burnt to carbon dioxide, represents 147,200 calories, whereas something like 99,000 calories has been the limit of the power obtained." This sacrifice of 40% lends itself to reduction, as does the heat held in the stream of molten slag flowing from the furnace.

NASMYTH'S steam hammer gave the mean of forging iron, which led to rapid developments and improvements in the applications of iron. The reversing rolling mill engine of RAMSBOTTOM has been invaluable in the rolling of plates and bars of great dimensions.

The forging press, too, has been designed and improved by English inventors, to whom the world owes much for other mechanical appliances devised to meet the various wants of the Bessemer process and the treatment of masses of iron and steel.

To you probably the most important invention of modern times has been that of Sir HENRY BESSEMER. It has given you a material in quality and quantity for your railroads which it was a physical impossibility to obtain by the ancient methods of iron making. It is no exaggeration to say that without the Bessemer process for steel rail making the present railway system in the United States would not now exist; and in the settlement of the new lands you have peopled and the binding together of the vast territory between the Atlantic and the Pacific under one civilized power, would not yet have been effected.

The SIEMENS-MARTIN process for the manufacture of open-hearth steel met with its greatest development in England, and it has enabled us to produce a material suitable for the requirements of the ship builder of which he has availed himself to a vast extent. In Great Britain the production of Bessemer steel ingots in 1889 was 2,140,791 tons; of open-hearth steel ingots, 1,429,169 tons. We in Great Britain and Ireland are justly proud of our mercantile marine. The supremacy of our shipbuilders and of our shipping interest is based upon the excellent quality and the abundant supply at a moderate price of steel furnished by our steel makers

The strength of our position and the remarkable economy of this important industry can be best demonstrated to you by a fact within my own personal experience. I have, within the past two months, as chairman of a ship-

ping company, entered into contracts for the purchase of several new first-class cargo steamers, to be built of steel of the most approved design, with triple expansion engines, at the cost of £7 per ton registered tonnage. These ships will have a carrying capacity of 4,000 tons.

An interesting example of the use of refuse is the employment of basic slag as a manure. This was first applied as a manure in England in the summer of 1885 by Professor WRIGHTSON, of Downton, Salisbury, who was employed by the Northeastern Steel Co. to make a series of experiments. The results were so satisfactory that basic slag immediately became a marketable article instead of a waste product. Now, in the 12 months ending June, 1890, 103,630 tons were delivered from the works in Great Britain. Owing to the very much more rapid development of the basic process in Germany, a very much larger quantity of slag has been produced, and during the past three or four years not only has the whole make been utilized, but stocks have been used up, as well as a considerable proportion of the total quantity exported from England. The make of basic slag in Germany is estimated at about 325,000 tons for the year 1889. The average analysis of ground basic slag shows 45.61% of lime.

It may be stated, in general terms, that owing to the high cost of aluminum it cannot at present come into extensive use. Mr. HADFIELD and M. OSMOND agree that iron with silicon and iron with aluminum have many points of resemblance. But when the addition of 1% of aluminum, the minimum amount that has been found efficacious, means an addition of from 12s. 6d. to 20s. per ton on the cost of the steel ingot, its employment in competition with silicon, as "ferro-silicon," or "silicon spiegel," cannot be more than experimental. I hear, however, an American company promises the production of aluminum at a much lower cost than the cost of a year ago.

The remarkable success which has rewarded the researches of inquirers and experimenters on the alloys of steel with chromium, tungsten, aluminum and nickel, gives us good reason to stimulate our members to continue their exploration of this field. Amongst these alloys the most important results appear to have been obtained from the use of nickel as an alloy of steel.

Since Mr. JAMES RILEY'S valuable communications on the subject of the alloys of nickel and steel, in May, 1889, continuous experimental research has been made into this matter. The treatment of large masses of steel by tempering, hardening and annealing, in water, oil, or molten metal, has been carefully studied, but the secrets of the behavior of masses of steel in heating and cooling are yet far from being unfolded.

M. OSMOND, in his excellent paper delivered before the International Congress in Paris last year, points out that tempering in oil was known to the ancients—being mentioned by PLINY; and SHAKESPEARE also knew that the Moors had the knowledge that different temperatures of water effected the results of the hardening process. Othello says: "I have another weapon in this chamber; it is a sword of Spain, the ice-brook's temper." One day, in conversation with Mr. GLADSTONE, I related this to him. He at once capped the quotation by saying: "Yes and I remember that HOMER, in the 'Odyssey,' says: 'As when the smith dips into cold water a great axe or an adze, and it hisses loudly as he is tempering it, for so it is that iron is made hard.'"—*Odyssey* ix., 391-4.

The speaker closed with the expression of his belief that the United States and England were necessary to each other in the interchange of products and brains, and he was convinced that "through such orderings Providence has designed to wind the silken chain of commerce round the world."

A New Process for the Manufacture of Copper Articles.

Companies have been organized in England to acquire and operate in England and France the patents taken out by F. E. ELMORE and A. S. ELMORE, for manufacturing copper articles direct from rough copper bars. Sir JAMES D. MACKENZIE, formerly connected with Sir. W. G. Armstrong, Mitchell & Co.'s works at Pozzuoli, Italy, is managing director of the company to operate in France. This invention, as described, does away with the processes of melting, rolling, forging, drawing, etc., and the present costly and laborious methods of manufacturing copper articles, such as tubes, vats, cylinder, pans, printing rollers, wire for electric purposes, and a number of other articles.

By this process copper is electrically deposited from the rough bars upon a revolving mandrel or mold, upon the face of which a burnisher is caused to move automatically for the purpose of condensing the copper particles as they are deposited, thus not only rendering the material dense, silky, fibrous and cohesive, with a strength, ductility and uniformity at present unobtainable, but producing the articles automatically during the process of refining the copper at a low cost.

The advantages of the process as applicable to copper are summed up by the inventors as follows:

1. That in the making of tubes and similar articles by this process all drawing down and brazing is entirely done away with.

2. That there is practically no limit to the diameter of seamless pipes and other articles that can be produced.

3. That many copper articles, especially large tubes, vats, cylinders, etc., can be produced direct from rough copper far more cheaply than by any other process.

4. That the electrical conductivity of the annealed copper has a conducting power of 4⅛% above that of the best guaranteed commercial copper.

5. That the copper articles produced by the process have been proved to have absolute uniformity of density, thickness, tensile strength and true circular section.

6. That the copper can be varied in tensile strength and ductility according to requirements.

Three Recent Designs for Movable Weirs.

In a recent number of the *Centralblatt der Bauverwaltung* is a description of some recent designs for movable weirs by Herr NAKONG, one of the resident engineers of the river improvements at Cosel described in ENGINEERING NEWS of May 3. From his article we abstract as follows:

Fig. 1 is a section of a folding weir suitable for small streams. The face of the flap and the cylindrical surface opposed to the water are covered with sheet iron, thus forming a box or chamber into which water may be admitted by a three-way cock from the upper or lower levels. In the position shown in the cut the chamber is in connection with the higher level and the pressure within and without the cylindrical portion is the same. In order that the pressure exerted against the flap shall not overthrow the sector, causing the flap to lie on the lower sole of the weir, a catch is fastened at *a* by means of an anchor, as shown in the cut.

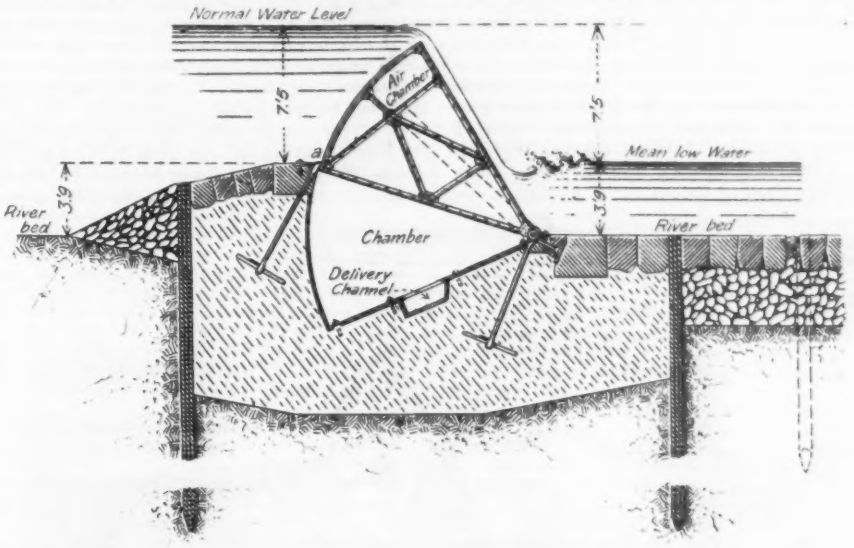
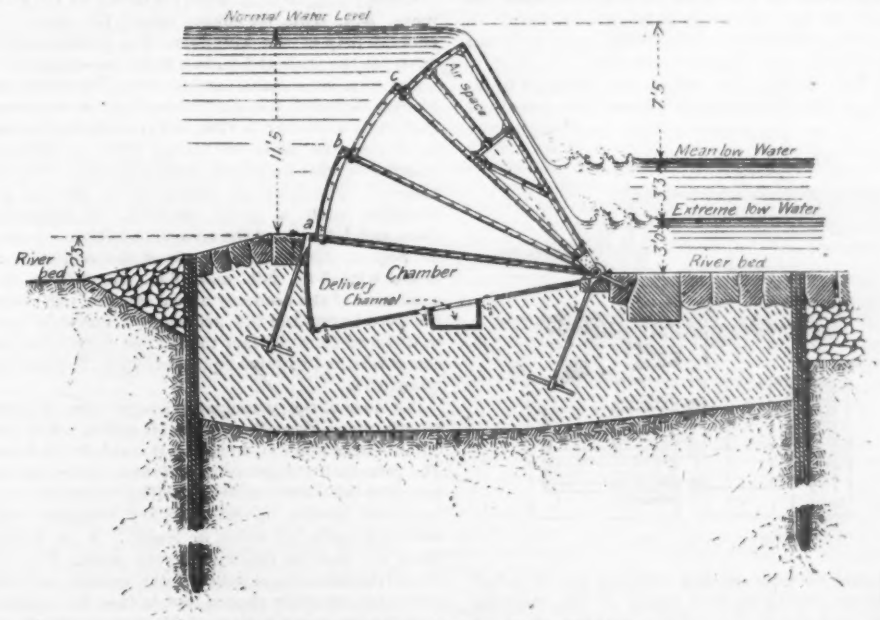


FIG. 1.—FOLDING WEIR, ONE VALVE.

If the flap is to be laid down the chamber is connected with the lower level, when the excess of downward pressure and the weight of the structure causes it to fall. When the weir is to be again raised the chamber is connected with the upper level and the flap is subjected to a sufficient pressure to make the weir rise. The head necessary for this purpose is usually obtained by placing a sufficient number of needles against the working platform, which is generally built in connection with these dams (see Fig. 4).



F.G. 2.—FOLDING WEIR, THREE VALVES.

In order to obtain as water tight a joint as possible at *a*, strips of thin spring steel are fastened to the masonry, as shown in the cuts. These strips are 3 to 4 ft. long, since it has been found in similar cases that the joint is much closer when short pieces are used than when the strip is continuous. In the upper part of the movable portion of the weir is an air chamber which is useful in raising the flap.

A comparison between the cost of such a weir and

that of a needle dam of equal height shows little difference between the two, while the cost of working and maintaining the folding type is much less.

It is probable that these weirs can be operated in lengths of 75 to 100 ft., provided that the delivery channels are of sufficient size.

A modification of this type, suitable for deeper streams, is shown in fig. 2. Here the movable portions are jointed like a fan, but otherwise the plan is unaltered. At *a*, *b* and *c* there are fastened strips of spring steel in order to give a water-tight joint.

In Fig. 3 is represented a different type. Here the upper valve of a drum weir carries a cylindrical addition on its lower face in such a manner that three chambers are formed. In the position shown in the cut, the front and rear chambers are connected with the upper level and the middle chamber with the lower level by means of a four-way cock. Since the pressure holding the valve in position is distributed over two faces, these can be made about half the width of the upper part which dams the water. To lay the weir, it is only necessary to connect the middle chamber with the upper level and the front and rear chambers with the lower level.

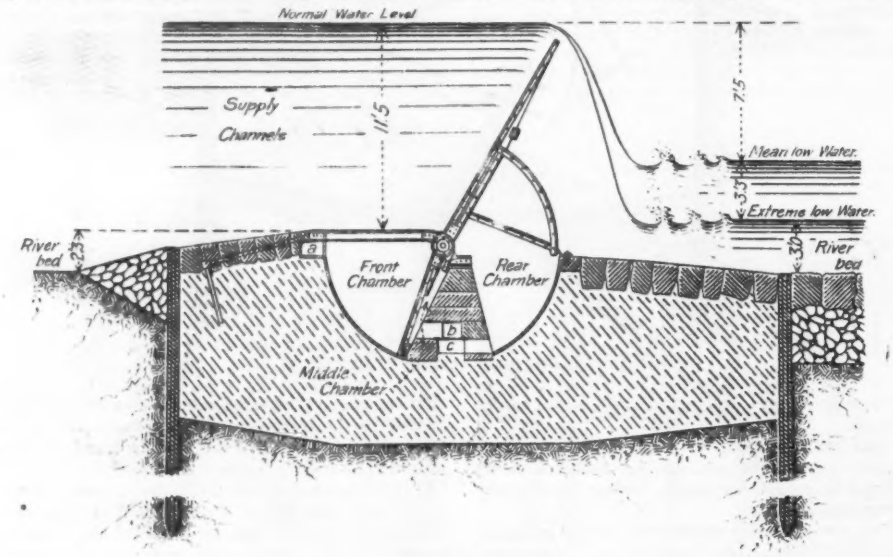


FIG. 3.—FLAP WEIR.

Fig. 4 is a sketch of the rolling weir designed by M. CARRO, a French engineer. The wooden panels of this design are each supported by two ties attached to rods connecting the foot plates of the working trestles, and also by two wheels running on short pieces of railway rails as shown in the cuts. In the original Chanoine weir, of which this is a modification, there are but three points of support, which necessitates the use of narrow panels.

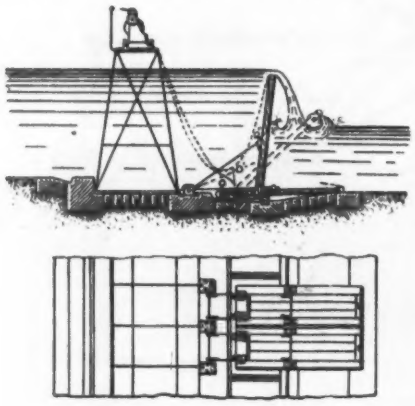


FIG. 4.—Carro Weir.

By carefully adjusting the point of attachment, *o''*, of the stays, the weir can be made to drop automatically. All that is necessary is to place *o''* at such a point that the moment of the water pressure above this level will not exceed that below until the depth of water has reached the allowable maximum. When, however, this maximum level has been reached, any greater rise should cause the moment of the upper stratum of water to exceed that of the lower, thus overturning the panels.

The British Ordnance Survey.

In a resumé of the publications of the Ordnance survey for England and Wales, by Mr. EDWARD STANFORD, of Charing Cross, London, sole agent for the sale of all the Ordnance and Geological Survey maps, an interesting account is given of the commencement and progress of the great work. The National Survey of the United Kingdom was commened in 1791 under the Board of Ordnance—whence its name—for military purposes on the scale of 1 in. to a mile, and was carried on in Enland from south to north until the borders of Lancashire and Yorkshire were reached in 1824. The survey of Ireland was then undertaken and carried out on the scale of 6 ins. to the mile, and on the resumption of the English survey this larger scale was continued. About 1862 the scales finally adopted for the Ordnance Survey maps were: $\frac{1}{1056}$ or 10-ft. scale for towns of more than 4,000 inhabitants (excepting London); $\frac{1}{2500}$ or 25-in. scale for parish or cadastral maps, 6-in. scale for county maps; 1-in. scale for a general map of the kingdom. For London and its environs the scale of 5 ft. to a mile was adopted.

For such large scales extensive base lines were obviously required, and one 7 miles long on Salisbury Plain was measured in 1794, and another 8 miles long in 1827, on the shore of Lough Foyle in Ireland. These measurements were subsequently verified and adopted. The principal triangulation covered the kingdom with a great network of imaginary lines, and determined the accurate positions of some 250 points. The measurements of the angles were made with 3-ft., 2-ft. and 18-in. theodolites, and some idea of the accuracy aimed at and the labor involved in making the necessary corrections may be deduced from the fact that in one calculation the computers had to solve equations with 77 unknown quantities.

The sides of the principal triangles are of great length, many exceeding 80 or 90 miles, while the longest from Sea Fell to Slieve Donard, is 111 miles. The principal triangulation is divided into secondary triangles with sides of 10 to 15 miles, these latter being again broken up into tertiary triangles with sides averaging 1½ miles in length. It is within these last that the chain surveyors work. For the great trigonometrical points lofty towers and hill tops were generally chosen, but in the flat eastern counties the use of high scaffolds were resorted to. One of the most remarkable was that erected on Thaxted Church, Essex, the theodolite being placed 6 ft. above the summit of the spire, and 180 ft. above the ground.

Up to 1853 all Ordnance Survey maps were engraved on copper, but in 1854 lithography was adopted for the larger scales, as being more expeditious and less expensive. This, in its turn, was rapidly displaced by zincography, and now, since 1889, photozincography has been finally adopted as the most certain and rapid mode of reproduction, and is used for the $\frac{1}{500}$, $\frac{1}{2500}$ and 6-in. scale maps, the 1-in. scale map alone being engraved.

The resumé from which we have taken the foregoing extracts also gives interesting accounts of the organization of the department, the treatment of the manuscript plans and the preparation of the various maps. A perusal of this short account gives some idea of the vast work undertaken and the completeness and care with which it has been executed. Railway companies have great cause to be satisfied with the results, and the nation at large owes a debt of gratitude to those who have thus mapped out and recorded every feature of the country likely to assist in the determination of boundaries.—*London Railway News.*

Legal Decisions of Interest to Engineers.

Evidence in Personal Injury Case.—Where the employé of a railroad company sues to recover damages for injuries sustained by reason of defective appliances, the fact that after the accident the defect complained of was remedied, is in itself no evidence of negligence. But as showing the opinion of the company that a liability on its part existed, it is proper to show attempts on the part of the agents of the company to secure a release of all claims for damages, if such attempts were made by persons authorized to make them (St. Louis, A. & T. Ry. Co. v. Jones, Supreme Court of Texas, 14 S. W. Rep, 308.)

Unguarded Turn-table.—A railway company is liable for its negligence in leaving a turn-table unguarded, whereby a child 5 years old is injured, though the negligence of a responsible person in turning the table may have contributed to the accident. (Gulf C. & S. F. Ry. Co. v. McWhister, Supreme Court of Texas, 14 S. W. Rep., 26.)

Liability for Condition of Private Switch.—The night yard master of a railway company was injured while switching, by stepping into a hole in the platform of a set of platform scales of a coal company situated upon a side track that was used by the railway company in pulling out the cars of the coal company. The yard-master worked only at night, and did not know of the condition of the scales. A master is bound to furnish its servants with suitable and reasonably safe tools and appliances for the work they are required to do, and the title to its tools, whether owned by them, leased or borrowed, or otherwise in their possession for use, is wholly immaterial, for between the servant and the master they are the tools of the master, and he is liable to the servant for injuries received by reason of their defects. So the fact that the scales in question were not owned by nor under the contract of the railway company was no defence to the action of its employé for the recovery of damages for injuries sustained while crossing them in its service. (Little Rock & Ft. S. Ry. Co. v. Cagle, Supreme Court of Arkansas, 14 S. W. Rep., 89.)

Extent of Water Companies' Powers.—The charter of a water company which authorizes it to take water from a stream to supply a town with water, "for extinguishment of fires, and for domestic, sanitary and other purposes," will not allow it to take more water than it ordinarily needs for the purpose named, in order to use the surplus to supply power to manufactories, as this would be an injury to the mill-owners below the company's dam, without compensation, which is unconstitutional (In re Barre Water Company, Supreme Court of Vermont, 20 At., Rep. 109.)

Negligence in Care of Dangerous Appliances.—The conductor of a train on defendant's railway placed some torpedoes on the track for the purpose of scaring some of the passengers; a boy got hold of one and was injured; in an action to recover damages the following rule of law governs: "If a master has a duty to perform, and trusts it to a servant, who disregards it to the injury of another, it is immaterial, so far as the liability of the master is concerned, with what motive or for what purpose he neglects the duty." (Pittsburg, Chicago & St. Louis Ry. Co. v. Shields, Supreme Court of Ohio, 24 N. E. Rep., 658).

Condemnation Proceedings Under Law of Eminen Domain.—The map, profile and notice required by general statutes of Kansas need not be given or filed prior to the commencement of proceedings for condemnation of the right of way for a railroad company. The failure of a railroad company to file a certified copy of the commissioners' report with the register of deeds within the time prescribed by the statute, when it does not injuriously affect the land owner or prejudice his rights in any way, will not invalidate the proceedings. (Chicago, K. & W. Ry. Co. v. Abbott, Supreme Court of Kansas, 24 Pac. Rep. 52.)

Location of Station on Line of Railway.—The duty to maintain or continue stations by a railway company rests upon the principle that a company cannot be compelled to maintain or continue stations at points where the welfare of the company and the country in general require that they should be changed to some other point. Where a company removed a station from one point to another a mile or so distant, they cannot be compelled to maintain a station at both points when there is only business enough for one. (Mobile & Ohio Ry. Co. v. Hunt, Supreme Court of Illinois, 24 N. E. Rep. 642.)

Street Improvements—Revival of Contract.—If a contract for paving streets contain no stipulation as to time of completion, but provides that it shall be done in compliance with the city ordinances, the contract is void if not completed within two years, as that is the period limited by the Philadelphia ordinances. When a void contract is revived by the city after the price is reduced for future work, by ordinance the price so established will govern. (City of Philadelphia v. Jewells estate, Supreme Court of Pennsylvania, 19 At. Rep., 947).

Master and Servant—Doctrine of Fellow Servant.—Where the evidence is that the track inspector of a railroad company and his gang went over a curve about two weeks before the accident occurred, and examined it carefully and repaired it for service; and where it appeared from the evidence, if the railroad company was guilty of negligence at all it was in regard to the condition of the track at this point, an engineer who was injured in the accident cannot recover, as the approximate cause of the injury was the negligence of a fellow servant. (Burrel v. Gowan, Supreme Court of Pennsylvania, 19 At. Rep. 678.)

Sir Henry Bessemer's Story of the Invention of the Bessemer Process.

Sir JAMES KITSON presented at the Pittsburg meeting of the Iron and Steel Institute an extremely valuable letter from Sir HENRY BESSEMER, which he advised the Institute to preserve in its archives as one of its most valuable papers. The letter describes the way in which a casual discussion with a French officer on the best metal for cannon led to investigations extending over a year and resulting in the production of an excellent grade of soft steel. The great interest aroused by the first paper on the new process, "On the Production of Malleable Iron Without Fuel," is mentioned, and also the reaction in public sentiment when it was found that the method would only apply to high grade charcoal pig. The years of patient toil and costly experimenting that followed, and the marvelous success that at last repaid for the long struggle, are narrated in such an interesting manner that the letter will always remain one of the leading documents in the history of industrial science. We give below the full text of this remarkable story of the invention of the most valuable process in the metallurgy of steel.

It is with great pleasure that I accede to your request to furnish you with a brief outline of the circumstances which led to the invention of my steel process. At the time of the Crimean war I had invented a mode of firing elongated projectiles from a smooth bore gun, the rotation necessary to insure their proper position during flight being obtained by utilizing a portion of the powder gas to produce rotation by reaction, after the manner of producing rotation in turbines, and not by the rifling of the gun, consequently rendering all smooth-bore guns at once suitable for firing elongated shot and shell. I of course offered this plan to our own government, but it was discarded without a trial.

A little after this period I happened to be on a visit for a week or two with Lord JAMES HAY at the house of his daughter in Paris. During this visit our host gave a farewell dinner to Gen. HAMLIN and several other distinguished officers in the French Army, who were going out to the Crimea. Among the guests on this occasion was Prince NAPOLEON, and while taking a cigar in the library after dinner the conversation turned naturally enough on artillery, and I then mentioned my system of firing elongated projectiles from smooth bore guns. The Prince was so impressed with the importance of this idea that he said he was sure that his cousin, the Emperor, would be much pleased if I would explain my invention to him, and that he would get an appointment made with the Emperor for this purpose. This was done, and I had a long and most interesting discussion with His Majesty, whom I found most thoroughly conversant with the whole subject of artillery. His Majesty, in the kindest possible way, gave me a carte blanche to make any experiments I desired at Vincennes.

A great many 30-pounder elongated projectiles were made, and were fired from 4½-in., 12-pounder, smooth-bore cast iron gun at the Polygon at Vincennes. They were fired through a succession of thin wooden targets 100 meters apart, through all of which they cut circular holes, thus showing that they went end on; a thin coat of black japan had been purposely put on them, and when the shots were recovered from the bank in which they were lodged the coat of japan was seen to be partially scraped off in spiral lines; caused by their passage through the wooden target; the angle of these scratches being carefully taken, showed that from 1¼ to 2¼ rotations had taken place in the length of the gun.

After many hours' practice, on a cold December day, we retired to the officers' quarters in the old fortress of Vincennes, and while standing around a blazing wood fire, sipping some hot spiced wine, Commandant MINIE (the inventor of the rifle) observed "that, although the rotation of the shot was effected, unless we had something better to make our guns of, such heavy elongated projectiles could not be used with safety." This casual observation was the spark that has kindled one of the greatest industrial revolutions that the present century has to record, for during my solitary ride in a cab that night from Vincennes to Paris I made up my mind to try what I could do to improve the quality of iron used in the manufacture of guns.

My knowledge of iron metallurgy was at this time very limited, but this was in one sense a great advantage to me, for I had very little to unlearn, and so could let my imagination have full scope. After many months of trial and much building up and pulling down of reverberatory furnaces, I cast a small model gun; the iron was very white, and in turning it little short curly shavings were cut off. It was wonderfully tough for cast iron, but wonderfully brittle if classed as wrought iron. The little model gun looked very beautiful when highly polished, and I took it to Paris and begged the emperor to accept it as the first fruits of my studies of the metallurgy of iron. He expressed himself much pleased with it, and complimented me on having achieved a step in the right direction, and with his own hands placed it in a bureau, saying: "Some day it may become an interesting relic."

About this period I began to fully appreciate the fact that if I could improve cast iron and render it malleable, and still retain its fluid state, that, apart from its use for artillery, it would be of the greatest commercial value for all engineering purposes. I therefore pursued my experiments with greater ardor than ever, for I was convinced that I was on the eve of producing a quality of metal that would supersede wrought iron.

At this time I devoted myself exclusively to these investigations, which were very costly, and I became most anxious to obtain the opinion of some able engineer as to the value of my invention, lest I might be deceiving myself and living in a fool's paradise.

I consequently consulted Mr. GEORGE RENNIE, the eminent civil engineer. I showed him a small upright fixed cylindrical converter, and in it we made a charge of 7 cwt. of Blaenavon pig iron into an ingot of malleable iron. Mr. RENNIE was in raptures with the result, and said:

"You must not keep this light under a bushel for a single day longer; and, by-the-bye, there is a first-rate opportunity for you. The British Association meet at Cheltenham next Tuesday; read a paper there by all means. I am President of the Mechanical Section; it is true all the papers are arranged, but if you will write a paper I will take the responsibility of putting it first on the list." He kept his promise, and I read my paper "On the Manufacture of Malleable Iron without Fuel," which appeared verbatim in next day's *Times*.

The entire iron trade of the kingdom was startled by the facts detailed in this paper, backed as they were by two small bars of malleable iron, one of which had been piled and rerolled; a few days later the iron masters came trooping up to London to see the new process. There are many interesting incidents connected with these visits, which I cannot trespass on your time to relate; but some idea of the excitement may be gathered from the fact that, notwithstanding the imperfect state of the process at that time, I was actually paid £27,000 for licenses granted within one month of the reading of my paper. At many iron works the managers set to work to test the invention in the rudest possible manner, with such means as they had at their disposal, all of which attempts were failures. In my experiments I had used Blaenavon pig iron, which was successful, and at that time I had no idea that other brands of iron would fail in the manner they did. No sooner were these failures known than an extraordinary revulsion of feeling was manifested, and the most perfect distrust of the invention became universal. The public press, which had spoken of it in such glowing terms, now condemned it as impracticable, and spoke of it as "a brilliant meteor that had fitted across the metallurgical horizon, dazzling a few enthusiasts, and then vanishing forever in total darkness."

Prior to this invention pure malleable iron in a fluid state was wholly unknown; indeed, whole days of exposure to the most powerful furnaces then in use entirely failed to bring this material into a state of fusion, notwithstanding which I proposed to convert ordinary melted cast iron into this malleable fluid state, in quantities of five tons at a single operation, and in the short space of fifteen minutes, by the mere chemical action of cold, atmospheric air, and in the entire absence of any fuel whatever, except that which existed in the form of carbon and silicon in the crude metal itself. It is not surprising, therefore, that the ironmasters, as well as the whole press, joined in one general chorus of condemnation of what they believed to be a perfect chimera, which none but a wild enthusiast could have believed to be possible. I knew far otherwise, but this was no time to argue the question. Words would have been of no avail, so I set earnestly to work to try and master the difficulty that had so unexpectedly arisen; this was no easy task.

All the old investigations had to be gone over again; experiments on a much larger scale, with larger and more powerful machinery, were found necessary; but the difficulties to be surmounted had reference more to chemical than mechanical questions; a laboratory was therefore fitted up, and I engaged the services of a professor of chemistry, at a high salary, to make an analysis of all the iron, and the materials employed in our experiments, as well as a systematic analysis and classification of all the results obtained. The very large scale on which these operations were carried out involved a considerable outlay in various ways, but there was no slackening of exertion, no cessation of the severe mental and bodily labor; in this way another long and weary year had passed, and but little real progress had been made towards the removal of the difficulty; many new paths had been struck out, but they had led to no practical results. Several weeks were sometimes necessary to make and fit up the apparatus required to test each new theory as it was formulated, and it too often happened that the first hour's trial of the new scheme dashed all the high expectations that had been formed, and we had again to retrace our steps; thus week after week went on amid constant succession of newly-formed hopes and crushing defeat varied with occasional evidences of improvement. I, however, worked steadily on. Six months more of anxious toil had glided away, and things were much in the same state, except that many thousands of pounds had been uselessly expended and I was much worn by hard work and mental anxiety. The large fortune that was almost within my grasp seemed now far off; my name as an engineer and inventor had suffered much by the defeat of my plans. Those who had most feared the change with which my invention had threatened their long vested interests felt perfectly reassured, and could now safely sneer at my unavailing efforts; and what was far worse, my best friends tried, first by gentle hints and then by stronger arguments, to make me desist from a pursuit that all the world had proclaimed to be utterly impossible. It was indeed a hard struggle, and I had well nigh learned to distrust myself, and was fain at times to surrender my own convictions to the mere opinion of others. Those most near and dear to me grieved over my obstinate persistance—but what else could I do? I had the most irrefragable evidence of the absolute truth and soundness of the principle on which my invention was based; and with this knowledge I could not persuade myself to fling away the promise of wealth and fame, and lose entirely the results of years of labor and mental anxiety, and at the same time confess myself beaten and defeated. Happily for me, the end was nigh, and in a few more months I had fully succeeded in producing steel worth £50 to £60 per ton from charcoal pig-iron which had cost me only £7 per ton, the conversion of the crude iron into steel being effected by simply forcing minute streams of cold atmospheric air upwards through it for a space of 15 minutes.

Thus was the so-called fallacious dream of the enthusiast realized to its fullest extent, and it was now my turn to triumph over those who had so confidently predicted my failure. I could now see in my mind's eye at a glance the great iron industry of the world crumbling away under the irresistible force of the facts so recently elicited. In that one result the sentence had gone forth, and not all the talent accumulated during the last 150 years, of all the thousands whose ingenuity and skill had helped to build up the mighty fabric of the British iron trade - no, nor the millions that had been invested in carrying out the existing system of manufacture, with all its accompanying powerful resistance, could reverse that one great fact, or stop the current that was destined to sweep away the old system of manufacturing wrought iron, and establishing homogeneous steel as the material to be in future employed in the construction of our ships and our guns, our viaducts and our bridges, our railroads and our locomotive engines, and the thousand and one things for which iron had hitherto been employed; and yet, with all this newly developed power, I was paralyzed for the moment in face of the stolid incredulity of all practical iron and steel manufacturers, which stood like the solid wall of a fortress barring my way to the victory I had already won. I announced the fact of my complete success to the world, and held in my hands the most undeniable proofs of the truth of my assertion, but no one would now believe it possible. They remembered but too well the great expectations that were excited two years previously by the first announcement of my invention at Cheltenham, and were not again to be disturbed by the cry of "Wolf!" Thus it happened that, after the hard battle I had fought for so many years, I found myself as far as ever from the fruits of my labor, for not a single ironmaster or steel manufacturer in Great Britain could be induced to adopt the process.

Anxious to possess still further practical proofs of the value of my invention, I made a few hundredweight of bars at my experimental works in St. Pancras, of all the sizes and special qualities required in an engineer's workshop. These I took to the works of my friends, the Messrs. GALLOWAY, Engineers, of Manchester; and, unknown to any of their workpeople, these bars were given out and employed for all the purposes for which steel had heretofore been used in their extensive business. So identical in all its essential qualities was this steel with that usually employed by their workmen that during two months' trial of it not the slightest idea or suspicion that they were using steel made by a new process was entertained by them—in fact, they were accustomed to use steel of the best quality, costing £60 per ton, and they had no doubt whatever but what they were still doing so.

I may here remark that this tool-steel was made from Swedish charcoal pig-iron casting, delivered at Sheffield at £7 per ton, and it was with this high-class raw material that our firm continued for about two years to manufacture tool steel for engineers, for which we obtained £44 per ton, and with which such firms as Sir William Fairbairn, Sir Joseph Whitworth, Messrs. Sharp, Stewart & Co. were regularly supplied up to the time when larger and more profitable work had made it not worth our while to continue the manufacture of tool steel. Indeed, so satisfied were Messrs. WILLIAM and JOHN GALLOWAY with the crucial test of our tool steel at their works, that they entered into partnership as steel manufacturers with myself, my partner, Mr. ROBERT LONGSDEN, and my brother-in-law, Mr. ALLEN.

We built a steel works in the town of Sheffield, determined to beard the lion in his den and to undersell the trade until we forced them in self-defense to take a license under my patents and carry on my process. We

at once got to work, and dropped £10 per ton on railway tires, etc. This soon brought the trade to a proper frame of mind. Sir John Brown & Co. applied for a license; this was soon followed by Messrs. Charles Cammell & Co., and licenses were also granted to many other firms. Of course we thus created a strong rivalry with our own firm and forced our own prices down; this we were fully prepared for, as it still left a large margin of profit.

Some idea may be formed of i s importance as a manufacture when I state the simple fact that on the expiration of the 14 years' term of partnership of our Sheffield firm the works, which had been greatly increased from time to time entirely out of revenue, were sold by private contract for exactly 24 times the amount of the whole subscribed capital of the firm, notwithstanding that we had divided in profits during the partnership a sum equal to 57 times the gross capital; so that by the mere commercial working of the process, apart from the patent, each of the five partners retired after 14 years from the Sheffield works with 81 times the amount of his subscribed capital, or an average of nearly cent per cent every two months—a result probably unprecedented in the annals of commerce.

The Darby Process of Recarburization of Steel.*

As is well known, in order to produce in the Bessemer converter steel of a given percentage of carbon, two methods are in use. In one the process is stopped when the bath possesses the desired contents of carbon: by the other the bath is completely decarburized, and then the desired carbon is added in the form of spiegel, ferro-manganese, etc. In Germany the latter method only has been practiced; and it was retained when the Thomas-Gilchrist process for the production in the basic converter of steel, low in phosphorus, from highly phosphoric iron, came into general use, for from the nature of this process, before dephosphorization takes place, complete decarburization is necessary.

But while by the old acid process the carburization readily takes place by the simple addition of spiegeleisen, etc., the new process brought with it difficulties not easy to be overcome. The oxides, which are always present in the basic process to a larger or smaller extent, and also the phosphoric acid of the slag take part in the reaction. Even if one succeeded in removing part of the oxide by pouring off the slag and regulating the amount left dissolved in the bath by so perfecting the process that there would be approximately an equal amount remaining in each charge, and even if the danger of rephosphorization were diminished by as complete a removal of the slag as possible, and by suitable slag additions made to the still remaining slag, still the production of low phosphorus steel high in carbon could not be accomplished so readily as not to make the introduction of another simple method of carburizing well worth striving after. The circumstances are similar as regards the basic and acid open-hearth processes.

It can be readily understood, therefore, why after the introduction of the method of making steel in basic lined vessels, proposals which have been formerly made for the introduction of carbon other than by the indirect way, by means of spiegel, etc., but which had hitherto remained without results, should be brought forward again from various quarters. All of these processes were based on the known fact of the great affinity between carbon and iron at high heats. It was sought to reduce and carburize the bath of steel by the introduction of carburetted gases, by the addition of tar, petroleum, etc, as well as many mixtures of these substances with solid bodies such as burnt dolomite. However the result of all these experiments did not lead to the permanent introduction of any of them in practical work, until Mr. JOHN HENRY DARBY, the General Manager of the Brymbo Steel Works, succeeded in finding a solution of the problem.

Having noticed an increase of carbon in two pieces of steel which had been heated in a coal fire for welding, he experimented by bringing fluid steel into intimate contact with solid carbon. The result was a rapid absorption of the carbon by the steel. On the results of this experiment he founded his patented process by which fluid steel can be carburized by filtration through pieces of carbon, preferably in the form of graphite or wood charcoal. He employed for this purpose an apparatus in which the molten steel was filtered through charcoal.

Further experiments showed that the absorption of the carbon was so rapid as to make unnecessary the long time of contact, which the filtration gave. Mr. DARBY, therefore, constructed the apparatus shown in Fig. 1.

In this the filter is replaced by the vessel *B*, which is supported between the open-hearth furnace and the steel ladle, or between two other steel ladles. It is lined with refractory material and is furnished with a perforated refractory bottom plate. Above this vessel is placed the receptacle *H* containing the broken carbonaceous material. This receptacle is closed by a slide valve *S*, by the opening of which the carbon is allowed to fall, slower or faster, as desired, into the vessel *K*, and there mixes up with the fluid steel, which is thereby carburized and flows out through the holes in the bottom plate. As a rule the carburization takes place during the first third of the charge. The remainder of the soft steel then mixes up with the already carburized steel in the ladle to a homogeneous whole. The loss of carburizing material (graphite by burning is about 15% to 20%; when coke is used for carburizing the loss is greater.

Mr. DARBY'S experiments extended only to the carburizing of open-hearth steel, and he succeeded by his process, in conjunction with the basic process, in producing from the phosphoric raw material a very excellent product, which, with any wished for percentage of carbon to upward of 0.9%, contains only very small traces of other elements, and consequently is distinguished from all hitherto known open-hearth steel by its exceeding toughness. It has been worked up into chisels, knives, wire, etc., with the best results. And there was very great certainty of obtaining the right amount of carbon, the percentage obtained varying from that wished for seldom more than 0.01% to 0.02%. The rolling quality of the material, although only very small additions of ferro-manganese or ferro-silicon were made, was very good. The process was very soon exclusively employed at Brymbo, for the harder steels.

In order to apply his system to the Bessemer process, Mr. DARBY, in 1889, entered into an agreement with the Phœnix Co., of Laar, near Ruhrort-on-the-Rhine. The process was applied in the basic Bessemer works with a modification of the apparatus shown in Fig. 1. The carburizing vessel was arranged between the two ladles,

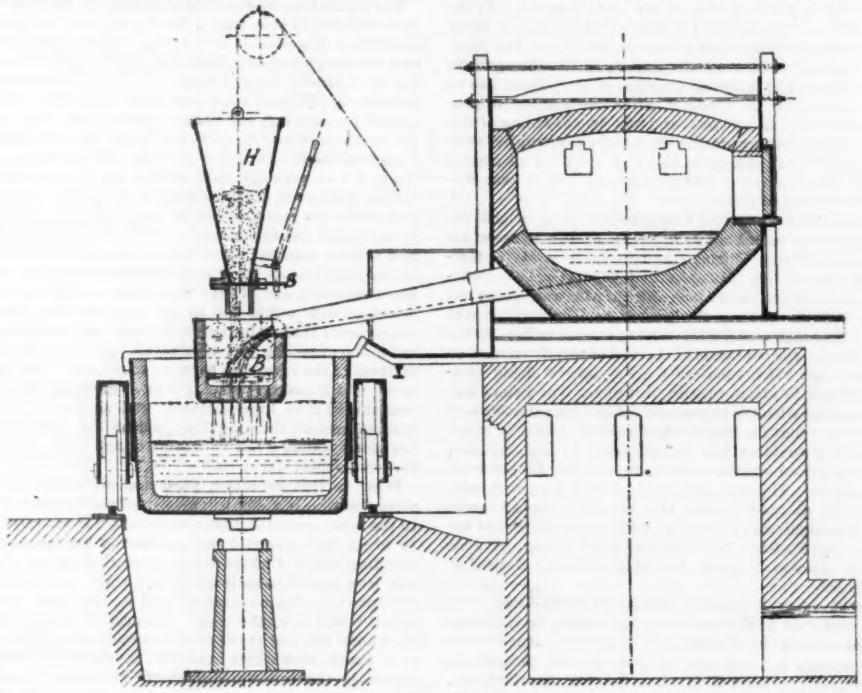


FIG. 1.

standing one over the other, and the steel was carburized while flowing from the first into the second ladle by the stream of carbonaceous material falling into the upper ladle

It at once appeared, however, that the basic Bessemer steel, although readily carburized, yet thereby lost its rolling qualities to such an extent that the ingots fell to pieces in the rolls. The cause of this was discovered to lie in the method of carrying out the process, viz.: That for four minutes more than sixty fine streams of steel were oxidized by the exposure to the air. It was sought to overcome this drawback by replacing the sixty holes in the bottom of the vessel by one of suitable diameter. A considerable improvement in the rolling quality of the ingots was thereby produced; but the rolling quality attained was not equal to that of the ordinary basic ingots, and the apparatus was on this account superseded by a device in which the molten steel from the ladle flows through a funnel, into which flows also a small stream of pulverized carbon in a quantity regulated by a screw feed. By the employment of this apparatus the carburizing is safely done to the desired extent, and sound ingots are obtained.

The ground coke appeared to be more quickly absorbed than the graphite, so that the whole of the experiments were carried out with this material. The carburizing funnel was placed between the ladle and the ingot and with ingots, weighing 1,400 kilos, and measuring 16 in. square, the carbon was very equally distributed throughout. By some attention the frequently occurring increase of carbon in the top parts of ingots of this weight was successfully overcome by a lessened addition of carbon to the upper part.

Although this method of carrying out the process offered considerable advantages over the earlier way, yet it brought the disadvantage that the accuracy of the carburization was dependent on the workman's rate of rotation of the endless screw. To effect the rotation by mechanical means appeared impracticable, because it must continually be varied with the volume of the stream of molten steel, which varies according to the temperature and condition of the stopper hole.

It was noticed that the carbonaceous material, finely ground coke, is immediately absorbed at the first contact with the molten steel, and this led to an arrangement by which this latter drawback was obviated. By the arrangement shown in Fig. 2 the carbonaceous material can be added direct to the stream of molten steel flowing from the converter before it reaches the ladle, while the slag can be retained in the converter until the carburization is complete, by means of a suitable plate lined with refractory material or by a block of refractory material. The quantity of the carbonaceous material flowing out from the receiver is regulated by means of a slide valve.

During June, 1890, at the Phœnix works, 70% of the rail steel charges and also a number of charges for hard and soft basic steel were carburized in this way, all of which gave satisfactory results. It may be remarked that when carburizing basic Bessemer steel the same addition of ferro-manganese is required as for soft ingot charges or as is necessary for the production of hard steel with the use of spiegeleisen.

After a series of very successful results had been obtained in this simple way the process was employed also in the open hearth and acid Bessemer practice. The results obtained were so favorable that now the employment of the carburizing vessel is the regular thing at these works.

In conclusion, the advantages which this carburizing process offers in each of the methods for the production of steel is as follows:

1. In the basic Bessemer (Thomas) process: the carburization takes place in the almost complete absence of the slag, rich in oxides and phosphoric acid, consequently it proceeds with certainty; it is accompanied by no important rephosphorization, and is practicable for obtaining any desired percentage of carbon, without simultaneously increasing the manganese. By the omission of the spiegeleisen a considerable economy is effected.

2. In the acid Bessemer process: the carburization takes place up to the highest degree of hardness with far greater accuracy than by the help of spiegel, and without the increase in manganese consequent upon the employment of the latter process. Here also a considerable economy is effected due to the saving in spiegel. Trials of this process have been made in some American works.

3. In the open-hearth process acid or basic, the advantages obtained are very nearly identical with those mentioned for the Bessemer and Thomas processes, the very considerable cost of the ferro-manganese and ferro-silicon especially, being wholly or for the greater part avoided. The combination of the process with the basic open-hearth process permits of the production of a steel which for many industrial purposes can successfully compete with crucible steel. By this method also a material is produced, which in the future will find very advantageous employment as the raw material in the crucible steel process.

*Condensed from a paper by A. THIELEN, General Manager of the Phœnix Steel Works at Ruhrort, Rhenish Prussia, read at the Pittsburg International Meeting of Metallurgical Engineers.

For example: For the production in the basic converter of a rail steel of 50 (kgs. per sq. mm.) tensile strength there is required for the production of a charge of from 9 to 9.5 tons:

a) By the employment of the ordinary process:
Spiegeleisen, 10-12%.....600 kgs.
Ferro-manganese, 60-65%..... 80 "
b) By the employment of caburizing process:
Spiegeleisen ..... nil.
Ferro-manganese, 60-65%..... 80 kgs.
Coke..... 60 "

For the acid process the calculation also show itself in favor of the carburizing process.

If steel of similar hardness is to be produced in the basic open-hearth furnace, there is required for a charge of 10 tons output,

a) By the employment of the ordinary process:
Spiegeleisen, 10-12%.....250 kgs.
Ferro-manganese, 60-65%..... 80 "
b By the employment of the carburizing process:
Spiegeleisen..... nil.
Ferro-manganese..... 12 kgs. or less.
Coke..... 50 "

The economy resulting from the employment of the carburizing process is here considerable; a similar relation holds good in the acid open-hearth process. From the foregoing it is clear that the superiority of the carburizing process in regard to the question of cost becomes the more considerable the higher the grade of hardness of the material to be produced; to the advantage that the harder sorts of steel can be produced with far greater ease and certainty. There is to be added the very considerable economy in the cost of production, while by the old process the cost of production rose considerably with the hardness.

During July, 1890, there was effected in the carburizing process another modification, which considerably improved one of our leading products, viz., tires. We use for the manufacture of tires small ingots, containing sufficient material for one tire. These after being hammered into flat disks are perforated in the middle, this perforation being enlarged before the disk is reheated before rolling. This method requires that the surface of the ingots be without flaws, and it must also be free from pores, as all these deficiencies can be seen afterwards in the finished tire. The open-hearth steel obtained by the carburization process does not show immediately after the casting an absolute even surface. The carburized material was therefore not used for tires.

Experiments were made with aluminum, and by the use of this all difficulties were removed. By adding to the steel not over 0.01% of aluminum an ingot was obtained absolutely free from porosites and well suited for tires. Following up these experiments, several solid castings were made out of the carburized material, and these turned out equally satisfactory, being positively flawless.

[Accompanying the paper were tables of results obtained by the carburizing process. Basic Bessemer steel having carbon 0.082% and phosphorus 0.045% showed after carburizing, carbon 0.293% to 0.290% and phosphorus 0.054%. Basic open-hearth steel carrying 0.009% to 0.076% of carbon was carburized to obtain percentages varying from 0.51% to 0.8%. The percentage aimed at was reached with a variation of from zero to .018% but averaging only about .006%. In carburizing acid open-hearth steel where the percentage of carbon aimed at was from 0.28% to 0.80% the desired percentage was hit within from .004% to .006% in almost every case. In carburizing steel made in the ordinary Bessemer converter the results given were those obtained at the Homestead Works of Carnegie, Phipps & Co., and the percentage aimed at was hit with still greater accuracy. In the discussion on the paper, which was carried on by Messrs. GILCHRIST and SNELUS, the chief point of importance brought out was the care necessary in the selection of the carburizing material. It should have the least possible ash and be especially free from oxide of iron. It was also stated that as the recarburization is practiced in England, even the slight rephosphorization noted in German practice did not occur.—ED. ENG. NEWS.]

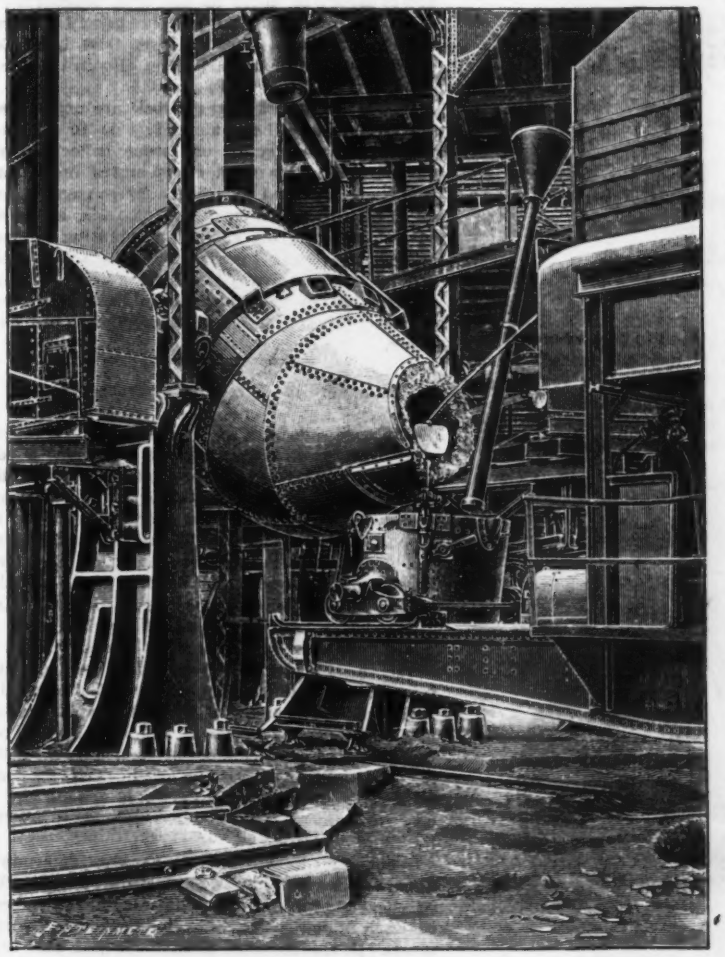


FIG. 2.—RECARBURIZING PROCESS AS APPLIED TO THE BESSEMER PLANT AT RUHRORT, RHENISH PRUSSIA.

Brennan Rock and Ore Crusher.

The Brennan rock and ore crusher, illustrated by the accompanying section and view, is not altogether new in the Northern market, since it has been quite extensively used for the last four years, but it has only recently come into very wide use. It has an unquestionable and decided advantage of principle over the older styles of rock crushers, which it may appear at first sight to closely resemble. The difference, slight as it is, is ingenious and important, and worth careful study.

The crusher works on the jaw principle, in contradistinction to the rotary or grinding crushers, it being said to be demonstrated that jaw crushers, of this type, at least, are far more economical in power than the rotary or grinding machines. They ought certainly to break the stone up in better shape and with less waste.

The device may be described as follows: As in the Blake and other older forms of crushers, the main shaft *P* is turned eccentric. The pitman *I*, resting on this shaft, is rising as the eccentric shaft revolves; this brings the toggles *H* and *J* nearly into line with each other. The toggle *J*, resting against a fixed point, leaves room for movement only in the direction of the swinging jaw *D* and the movable crusher plate *C* through the safety toggle *H*. The main shaft *R* is enclosed and runs in oil, consequently there is no heating, and excessive wear is obviated. The swinging jaw *D* is pivoted on the shaft *E*.

Thus far the action of the crusher offers no great novelty, but from this point forward it differs very materially from the action of most other makes.

It will be noticed that the movable jaw plate *C*, is held to the swinging jaw *D* by means of a hinged bolt at the top of the movable plate, and at this point only is the crushing plate attached to the swinging jaw. At and in the rear of the lower end of the crusher plate *C* is the shaft *G*, with its cam *F* ridigly attached. This shaft is operated by the hand wheel *Y* by means of a worm gear, the cam being only to fix or change the size of the lower opening. The action of the crusher against the material to be crushed is as follows: When the swinging jaw *D* moves forward it first comes in contact with the crushing plate *C only* at the upper end, during the early part of the stroke. This moves the *upper* end of the crusher plate *C* forward, while the lower end is at rest, and so the "butt end" of the crushing work, on the new large blocks, is done without having first to crush to powder the smaller material below. This action begins the disintegration of the material as soon as it enters the hopper, and this crushing action is continued *successively* in each stroke down the crushing plate *C* until the material has been discharged from the hopper reduced to the desired size, the throw being largest at the top and least at the bottom, as it should be, instead of *vice versa*. The lower material does not begin to crack up until the heavy work on the large upper blocks has been done. This successive application of the pressure to the material distributes the strain brought upon the crusher parts to an important extent, thus obviating the difficulty heretofore found with all jaw crushers, of having the entire load or strain of cracking up at once all the material between the jaws thrown on to the machine instantly, as is the case in machines where the swinging jaw and the movable crushing plates are attached rigidly together, each having the same motion.

Following the action of the machine on its return stroke, we find that the plate *C* follows the jaw *D* until its lower end strikes against the cam *F*, when it is stopped, and this at any desired distance from the fixed plate *B*, thus limiting absolutely the size of material discharged from the crusher. By turning the cam *F* more or less to the front the size of opening left between the fixed and movable plates is increased or decreased at will without stopping the machine. After the movable plate comes to rest against the cam *F* the swinging jaw *D* continues its backward movement until its stroke is completed, meanwhile leaving the movable plate *C* at rest, thus giving the material reduced to the desired size sufficient time to discharge, so that the fine material is not retained in the hopper and ground to powder, as in any crusher having a continuous movement.

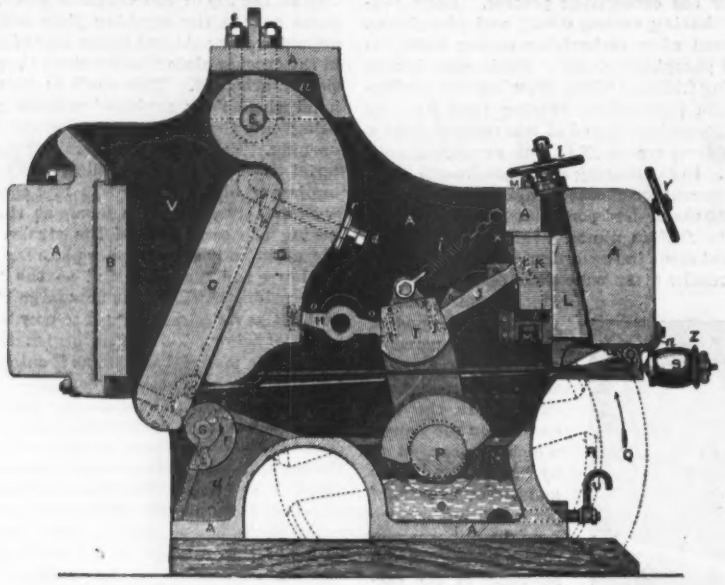
In this machine the crushing plate *C* is divided vertically into two or more sections, depending upon the size of the machine, each pitman having its own eccentric on the main shaft. These excentrics are turned at such an angle with each other as to give each section of the jaw plate with its swinging jaw *D* an alternating action.

Take, for instance, one of these machines with a capacity for receiving a stone 12 ins. × 37 ins., the length being 37 ins. The jaw plates are three in number, each 12⅓ ins. wide. But one of these sections is moving forward, crushing the rock, at any one instant, the other two sections being, one on the return stroke and the other just turning the center to move forward. This, together with the corrugations of the jaw, gives an uneven surface, by means of which the material is broken into cubes, and it is found almost impossible for a slab or piece of laminated stone, no matter how thin, to pass through the crusher without being broken into cubes.

The precise nature of the advantage of the Brennan type may be perhaps more clearly indicated as follows: Imagine the two jaws *C* and *D* to be firmly united into one, and the cam or bearing *G F* removed altogether. The breaker then becomes one of the older, original type.

Now it will be seen that under these conditions (1, in order to have enough motion at the top to properly crack the large blocks when first inserted, the jaw must have a considerable motion at the bottom,

and (2) that in order not to let out stone larger than is desired the lower part of the jaw when widest open must not move too far back; consequently, when the jaw moves forward, the lower part must of necessity, move further forward than is, desirable for the cracking work which it the lower part) has to do, for which even less motion is needed, as well as less power, than for the upper part. Consequently there is an in-



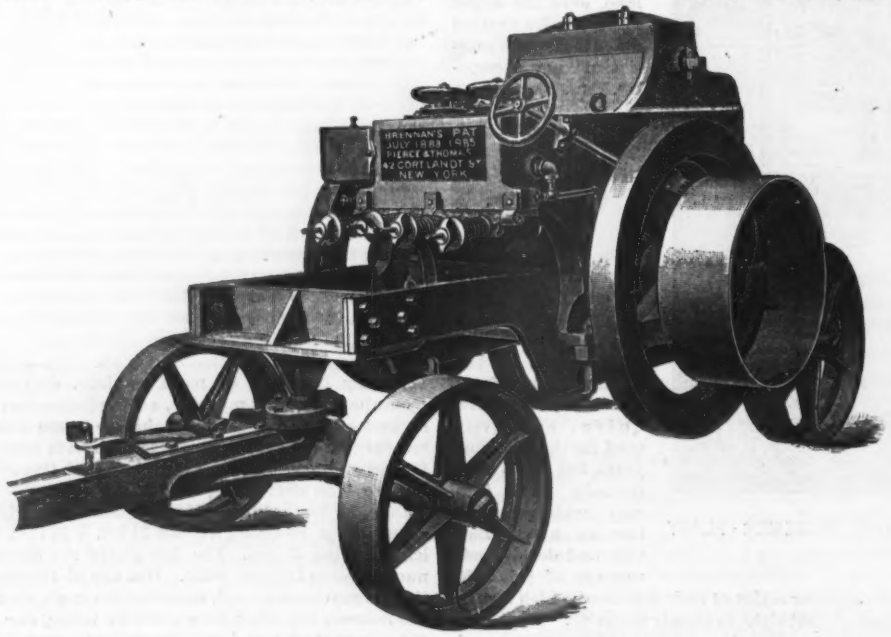
SECTION OF THE BRENNAN ROCK AND ORE CRUSHER.

evitable tendency to crack finer than is really desired, and to crush part of the stone into dust, as well as to choke the machine more or less by the enormous amount of crushing which must be done by the lower jaw before the upper part of it "gets in its work;" it being remembered always that the lower material cannot fall out as crushed to any large extent until the jaw begins to move back.

In the Brennan machine, on the contrary, there is an almost ideal distribution of the work of each stroke. First the upper part of the jaw does its work, with great leverage, unobstructed by the lower material; then the middle part of the jaw crushes with less leverage the middle part of the material; *then* only the compound jaw *C D* becomes a single one of the old type, and moves forward both with small motion and small power to crush the lower material. There should naturally be but little dust made, less strain on the machine, more economy of power, and more material turned out per hour.

These several features together make the product of the Brennan crusher not only well cubed, but make the large pieces of a uniform size. These points are absolutely essential in material for making perfect macadam roads, and the Brennan machine is claimed to be the only crusher which delivers the material in this shape.

It will be readily seen that the power required to drive this machine, compared with others of like capacity, must naturally tend to be very much less, as the power required at any one instant is only sufficient to overcome the resistance against one section of the crushing plate, the others at that instant being either on the return stroke or just turning the center. It is claimed to be shown by careful tests that the power required to drive the Brennan machine is 30% less than is required with any other rock crusher, either of the jaw or rotary type.



THE BRENNAN ROCK AND ORE CRUSHER.

The throw or length of stroke of the swinging jaw *D*, and through it the movable plate *C* is adjusted by means of the thumb screws *Z*, which, being tightened up more or less, compress the springs *S* in the same proportion. By this device any desired throw or travel can be given to the movable plate without stopping the machine. The wedge adjustment *L* is practically the same as used in the old form of jaw machines.

In a machine like a rock crusher, used for crushing all kinds of hard material, it is absolutely necessary that it should be provided with some weak part which will break when under undue strain, such as is brought upon it when a sledge hammer or piece of steel is put into the hopper with the material to be crushed. If such a breaking piece is not provided then some important and expensive part of the machine must give way. This breaking piece is provided in the Brennan machine by the safety toggle *H*. This is cast with a hole through it, so that it will break under undue strain, and it is the only part of the machine which will break if it has ordinarily intelligent attention and lost motion is taken up. This toggle is a simple casting, very quickly and cheaply replaced, and can be made in any foundry. The fixed crushing plates *B* and *C* are made reversible, so that when one end is worn out they can be turned and the other end worn out.

These crushers are built of sizes to give the following jaw openings in inches: 5 × 20, 7 × 20, 8 × 25, 10 × 25, 12 × 37 and 16 × 48. The several sizes have a capacity of from 10 to 100 tons per hour of material crushed to macadam size.

Among the localities where these crushers are largely used are the following: Mr. THOMAS A. EDISON is using 5 of them in his iron concentrating mills, the United Pipe Line Co. are using 4 in an iron concentrating mill, the Tomkins Cove Lime Co., N. Y., have 3 of them in service, Booth & Flinn, contractors, Pittsburg, Pa., have 5.

Where permanent ledges of rock are not convenient to the place where the product is to be used, making it necessary to use stone collected from various points, this crusher is mounted on a strong iron frame mounted on wheels for convenient and quick transportation from place to place, as shown in the accompanying cut. This mounting is made sufficiently strong to withstand the action of the crusher working an any kind of material. Further information can be obtained from Messrs. Pierce & Thomas, General Agents, 42 Cortland St., New York.

Engineering Work in Syracuse, N. Y.

Our correspondent in Syracuse, N. Y., reports that the census of 1890 gives that city a population of 87,877, an increase of 69.67% over the census of 1880. Streets are being torn up, reformed and paved, with the ancient cobblestone to be replaced with asphalt. The Warren-Scharff Asphalt Co. has 176 men at work on Onondaga St. alone. Street railway matters and electric roads are also being pushed vigorously. On Oct. 9 Dr. JOHN VAN DUYN, late Health Officer of that city, delivered to a large audience an address on the sewerage of Syracuse. He pointed out that the drainage system adopted in 1870 is altogether at fault, and insufficient for the needs of 1890; the rapid growth of the city was not foreseen. Dr. VAN DUYN then rapidly sketched the history of the sewerage of the old city, and pointed out the urgent need of a comprehensive and ample new system of sewers and a city government that would construct it on the lines laid down.

Skaneateles Lake seems to be now determined upon as a future source of water supply, and $500,000 city bonds issued for this purpose have been taken by Moller & Co., of New York, at $\frac{3}{16}$% premium. Of this amount, $250,000 has been paid into the city treasury, and the other half is to be paid within 30 days. As elsewhere mentioned, Mr. HENRY C. ALLEN has just been appointed City Engineer, and he finds his hands very full in the present rush of public works.

Electric Acid Bath for Photogravures.

The *Papier Zeitung*, of Berlin, announces that an important discovery has been made in the art of engraving, and especially in photogravure. As usual, the design to be engraved is placed on a zinc plate, either by photography or by an artist; this plate, backed by a coating of asphaltum, is then placed in an acid bath. In the new process the plate is put into connection with a dynamo machine, and the current is led away by a wire placed in the bath. As soon as the circuit is established the acid attacks the metal with an astonishing rapidity, and a few minutes are sufficient to bite in several millimetres deep. The depth of engraving can thus be easily regulated, a difficult matter under the ordinary process.

The Denver, Colorado Canon & Pacific Railway Project.

BY ROBERT B. STANTON, CHIEF ENGINEER.

The subject of a railway line from the western base of the Rocky Mountains to the Pacific Coast, by way of the low-grade water route of the Colorado River of the West, has become one of, at least, some little public interest.

I would therefore ask space in your journal to give some of the results of our recent survey from Grand Junction, Colorado, to the mouth of the Colorado River at the Gulf of California.

The *possibility* even—much more the practicability—of such a route has been questioned by many, from the supposed nature and form of the great canons through which that mighty river runs. After the disastrous ending of our first expedition, in July, 1889, I published in your issue of September 21, 1889, some descriptions and statements in regard to the route as far as we had then traveled—to the middle of Marble Canon. These statements were made in answer to certain published criticisms of Major J. W. Powell, Director of the U. S. Geological Survey, whose party, up to that time, had been the only one that had ever passed through these canons.

Since then, having completed my journey from the head to the mouth of the Colorado River, I shall now, in as short a space as possible, give a careful though general description of the nature of the valleys and canons of the whole route, together with tables of distances, quantities, etc.

In this discussion of the subject, I shall only take up this one feature—the *practicability* of the route. Not merely, however, the practicability from a purely engineering standpoint, but with reference to its construction within a reasonable amount of cost, and its future operation, and maintenance as a road for all the general purposes of a transcontinental line.

I shall not at this time take up the subject of the possible business of such a road—but will, if you shall so desire it, at no distant day, give you some information and tables of the traffic—local and through—which it would find ready immediately on its completion, and which it would in a very short time develop in the whole section of country through which it would pass.

That portion of the route from Grand Junction down the Grand River to the head of the Colorado, does not present any very remarkable features except in two points—the short Granite Canon, and perhaps some six tunnels, to cut off long bends of the river.

Since our survey, down the Grand last Spring, the Denver and Rio Grande Western Railroad has built a number of miles of road along this river below Grand Junction, on the opposite bank from our line, and is operating this new road every day. It would therefore be a useless expenditure of time and space to prove that this part is a practicable railway route. That portion built over by the Western does not differ materially from the whole route to the head of the Colorado, with the exception of the Granite Canon and tunnels referred to.

The tunnels are six in number, aggregating 4 11/100 miles (which will be found in the table further on), and in their construction would save some 23½ miles in distance. It is simply a question of cost and future operation whether the tunnels or the longer line should be built.

The Granite Canon, which in all is about 13 miles in length, does not present any difficulties not found in the granite of the Grand Canon, which will be described in detail, and illustrated by photographs, so that we may at once proceed to the canons of the Colorado River proper.

IN THE HEART OF MARBLE CANON. (Photo. 338.)

In my report to the Railroad Co. I have divided the whole route into subdivisions as follows:

	MILES.
The Grand River,	139.987
Cataract and Narrow Canons,	54.214
Glen Canon,	156.580
Marble Canon,	62.510
Grand Canon,	217.150
From Grand Canon to the Rio Virgin,	37.500
" Rio Virgin to Las Vegas Wash,	28.500

THE MOST DIFFICULT WORK, MARBLE CANON. (Photo. 332.)

	MILES.
From Las Vegas Wash to the Needles,	96.500
" The Needles to Yuma, and Yuma to the Gulf,	244.755
	1,037.696

These distances are by our survey and vary from the distances by the river.

In the report referred to I have given a detailed description of each piece of work, and class of material encountered along the whole line—from 100 feet in length and upwards—referring in each instance to a special photograph, showing, in almost every case, the exact piece of work described. This description covers many pages, and the photographs accompanying it number over nine hundred.

This description is then condensed into tables giving the length of each piece of work, and different class of material, in the order of their occurrence in this form, starting at head of Cataract Canon.

21,050 feet Level bottom land.
2,400 " Rough slopes, L. & S. R.
2,700 " Heavy embankment under cliff.
13,400 " Hillside slopes.
4,000 " Level bottom lands, etc., etc.

Even these tables are too long for your journal, and I must content myself with the final condensed tables, and reference to the photographic illustrations published for the several classes of work.

In my article in your issue of September 21, 1889, of Cataract and Narrow, is given the following description: From the head of the Colorado for 41 miles a railway can be built on easy slopes and long flats—with no cliff work at all—(by this I meant vertical cliff work)—through Narrow Canon

BELOW POINT HANSBROUGH, MARBLE CANON. (Photo. 350.)

the rock is harder and the slopes of the canon formed in benches are more precipitous. Photograph No. **85** (published then) shows some of the worst features, while the whole line can be located on these benches without at any point "hanging upon the sides of the cliff." Extending this description to Dandy Crossing, and condensing the detailed tabular account referred to above, we have the following:

TABLE OF CLASSIFICATION OF CATARACT AND NARROW CANONS.

Distance in Miles.	General Character of Work.	Characteristic Photographs Illustrating each Class of Work.
11.543	Level bottom land, earth, gravel, &c.	Photo. No. **39** & 114
5.436	Hillside slopes, E. & L. R.	" **48** & 78
14.545	Rough slopes, L. R. & S. R.	" 52 & 69
2.557	Solid rock slopes	" 106
19.110	Cliff bench-work	" **85** & 90
.739	Heavy embank., under cliff	" **44**
.284	Tunnel	
54.214	Total.	*

*Note.—It was found necessary to give a new set of numbers and complete system to our series of photographs on account of the loss of some negatives and replacing them on the second expedition. If in referring to the illustrations published in your issue of September 21, 1889, the reader will kindly change the numbers, as follows: it will save all confusion hereafter.

Old Number,	47	52	57	110	135	145	154	189
New Number,	**39**	**44**	**48**	**85**	**134**	**184**	**210**	**318**

The level bottom land is well illustrated by Photo. No. **39** (see issue September 21, 1889), and nearly all of it is plow and scraper work. The hillside slopes are earth, loose rock and gravel.

THE END OF MARBLE CANON. (Photo 372.)

The rough slopes are the heavy talus slopes, generally underlaid with horizontally stratified rock in place. The cliff bench-work is well shown in Photograph No. **85.**

In Glen Canon we find two or three peculiar features. 1st. A great distance of level bottom-land (plow and scraper work), formed in the wide portions of the river. These flats are well above ordinary high water. Photo. No. **135.** 2d. In a great part of this canon the walls are of massive red sandstone standing in vertical cliffs. This was shown in your former issue by Photo. No. **210.** For the greater part of the way there is at the foot of these cliffs a high, solid, and sufficient talus; but along some it is necessary to build the road bed in the river at the foot of the cliff, as in Photo. No. **210.** 3d. In the lower end of Glen Canon the river is very tortuous and to locate a good line will require some seventeen tunnels, from 200 feet to 4,640 feet in length. I have also estimated on an alternative line with longer tunnels making a saving in distance of 18½ miles.

TABLE OF CLASSIFICATION—GLEN CANON.

Distance in Miles.	General Character of Work.	Characteristic Photographs Illustrating each Class of Work.
57.270	Level bottom lands	Photo. No. **134**
10.928	Hillside slopes, E. & L. R.	
55.926	Rough talus slopes, L. & S. R.	" **318**
21.284	Solid rock slopes and bluffs	" **210**
6.553	Heavy embank., under cliff	
.501	Heavy through rock cuts	
4.118	17 Tunnels	
156.580	Total.	

THE WIDE PORTIONS OF MARBLE CANON. (Photo. 363.)

ALTERNATIVE LINE—GLEN CANON.

Distance in Miles.	General Character of Work.	Photographs Illustrating each Class of Work.
47.576	Level bottom lands	Photo. No. **134**
10.473	Hillside slopes, E. & L. R.	
45.519	Rough talus slopes, L. & S. R.	
17.812	Solid rock slopes and bluffs	" **318**
5.417	Heavy embank., under cliff	" **210**
.445	Heavy through rock cuts	
10.858	Tunnels, 19 in all	
138.100	Total.	

It is a question of dollars and cents, in a proper estimate, which is the better of these two lines. The tunnels would be through the massive red sandstone, soft enough to make cheap work, and yet hard enough not to require for a long time to come either timbering or arching,

LENGTHS OF TUNNELS—GLEN CANON.

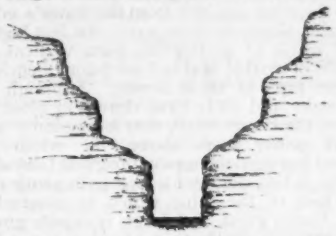
Surveyed Line.		Alternative Line.	
No.	Length in Feet.	No.	Length in Feet.
1	300	1	300
2	500	2	500
3	1000	3	6600
4	550	4	4000
5	1500	5	4500
6	4000	6	4000
7	200	7	200
8	800	8	800
..	....	9	6000
..	....	10	4600
9	1000	11	1000
10	350	12	350
11	300	13	2640
12	700	14	5300
13	4640	15	4640
14	600	16	600
15	500	17	5300
16	1500		
..	....	18	2000
17	3800	19	4000

THE WIDE PORTIONS OF MARBLE CANON. (Photo. 370.)

This brings our line to Lee's Ferry at the head of the *great* canons of the river—the Marble and the Grand Canon. They are, in fact, but one continuous canon having only an arbitrary division at the mouth of the Little Colorado.

We enter the head of the Marble Canon with a short tunnel through a sharp point, and beyond this for a distance of ten miles the line is upon good slopes of talus, in almost the whole distance underlaid by horizontally stratified rock in place, making a good and permanent roadway.

At this point the canon cuts into a much harder stratum of rock forming a narrow inner gorge with vertical walls next to the water for say 50 to 100 feet up. Above these the walls of the canon slope back in a general cross-section of this form:



In this inner gorge, being so narrow, the difference between low and extreme high water varies from 40 to 95 feet, but from the very nature of the case our line is on the first sloping bench above the inner gorge and well out of the way of the most extreme rise.

THE HEAD OF THE GRAND CANON. (Photo. 375.)

IN THE FIRST EIGHTEEN MILES OF GRAND CANON. (Photo. 385.)

This class of bench-work extends for 7½ miles, ending with nearly 3 miles of good talus slopes. Again the canon narrows up, and we have 11¼ miles of the same cliff bench-work. This extends to Point Retreat, where we left the river on our first expedition.

At Point Retreat, near the middle of Marble Canon, the river makes a sharp turn to the left and then again to the right. At this point the marble stands up in vertical cliffs about 300 feet high from the water's edge, while the sandstones bench back in slopes and cliffs to 2,500 feet in height. Just beyond this the canon is the narrowest, being but a little less than 400 feet wide from wall to wall. The marble rapidly rises till it stands in perpendicular cliffs 700 to 800 feet high, with patches of broken down cliffs forming small benches and talus slopes at their bases. (See Photographs Nos. 332 and 338 in this issue.)

Our line would pass through Point Retreat with a tunnel about one mile in length, cross the river with a single span, from cliff to cliff, and through the opposite point with a shorter tunnel coming out upon the same general class of cliff bench-work.

This section of some ten miles (two above Point Retreat) in Marble Canon is in fact the most difficult to locate and perhaps the most expensive ten miles to construct anywhere upon the whole river. It is necessary to cross the river for the first and only time. The closeness of the marble cliffs offers a very suitable place for a single span bridge. Although expensive, a permanent and first-class line can be located through this ten miles without, at any point, hanging upon the sides of the perpendicular cliffs.

This cliff bench-work continues for some 12 miles, with a tunnel through Point Hansbrough, thereby saving a mile in distance.

From Point Hansbrough to the Little Colorado, a distance of some 18 miles, the canon widens, the marble benches retreat, new strata of limestone, quartzite, and sandstone come up from the river, and the debris forms a talus equal to a smooth mountain slope.

See Photographs Nos. 350, 363, 370 and 372, for illustrations of this section.

At the mouth of the Little Colorado River—though it is only an arbitrary division—ends the Marble and begins the Grand Canon. (See Photographs Nos. 372 and 375).

TABLE OF CLASSIFICATION—MARBLE CANON.

Distance in Miles.	General Character of Work.	Photographs Illustrating each Class of Work.
.500	Bottom lands	
26.510	Heavy talus slopes*	Nos 330, 363, 370, 372
.125	Through rock cut	
32.250	Cliff bench work	" 318, 332, 338
.750	Heavy embank., under cliff	
2.375	Tunnels—(4 tunnels)	
62.510	Total.	

*Note.—Under "heavy talus slopes" are placed all slopes of talus and stratified rock in place covered with loose rock and debris.

We now come to the most wonderful part of the whole river route—*The Grand Canon.* In this have been supposed to exist all the terrors for railway construction that would for ever condemn the route. Let us look at it with this in mind, it is only the

IN THE FIRST EIGHTEEN MILES OF GRAND CANON. (Photo. 386.)

IN THE GRANITE GORGE ABOVE BRIGHT ANGEL. (Photo. 432.)

lower two hundred feet or so of the canon that our railway will have anything to do with.

For the first 18 miles the Grand Canon seems to have been upturned, tumbled over and mixed up in every imaginable shape, some of the oldest and newest formations standing side by side. The river runs through quite a wide valley. The top walls of the canon are miles and miles apart, and hills and knolls rise up between the river and the walls beyond. These being separated by deep washes and gulches running in every direction. (See Photographs Nos. 385 and 386.)

At the end of this broken country begins the little known but much noted Granite Gorge. This section of granite extends from a point 18 miles below the mouth of the Little Colorado River to the southern part of Powell's Plateau, a distance of about 36 miles, though there are patches of granite of more or less extent all the way down the Grand Canon.

It has a peculiar form all its own. Unlike the towering masses of granite of the Royal Gorge and Clear Creek Canons in Colorado, its walls start from the water's edge with generally a few feet—ten to fifty—of vertical cliff, and then slope back in a ragged, irregular slope 300 to 1,200 or more feet, at an angle varying from a few degrees to 45 degrees from vertical, with some small patches jutting out boldly into the river and towering hundreds of feet high, forming *almost* perpendicular cliffs, or rather, more accurately speaking, they form buttresses and towers to the general slope of the wall.

That portion of the Granite Gorge from its head to Bright Angel Creek has also a peculiar interest of its own. Narrow, dark and gloomy it stands at the very gate-way of the great canon, as if by its very frown to keep back the intruder and guard from vulgar eyes and sordid greed the grandeur, the beauty, and the hidden treasures of the lower canon. At the Bright Angel Creek everything changes; the granite slopes are flatter, they are of a softer, black granite cut into sharper pinnacles and crags, and seem more as if formed of very closely stratified slate. The Canon is much more cut up by side washes, and the whole country opens back into the widest portion of the Grand Canon, where the width *at the top* is from six to twelve miles. (For illustration of these sections see Photographs Nos. 420, 432, 441 and 469.)

From the southern portion of Powell's Plateau to the mouth of the Kanab Wash, the canon assumes an entirely new form. The granite, except in a few patches, has sunk under the river and the softer strata of sand and limestones which form the great slopes above the granite, have come down next to the river and rise from the water's edge in great talus slopes of from 300 to 600 feet high, at a general angle of 40 degrees from vertical. The high cliffs of marble and red sandstone bench back from the tops of these slopes. Although these outer peaks and cliffs have drawn in close upon the river, the canon itself, that is the inner gorge, is much wider than above, the width being measured between the tops of the great talus slopes. The river is broader, and it sweeps in gentle curves at the foot of the talus which is covered with bushes, bunch grass and large mesquite growths. (For illustration see Photographs Nos. 554 and 592.)

From the mouth of the Kanab Wash, for about 20 miles down, is perhaps the narrowest and deepest part of the great inner gorge. The lower sandstone and limestone ledges have sunken under the river and the marble and upper sandstone come close into the water. At the bottom the gorge is from 150 to 200 feet wide, and the river runs between vertical walls—vertical, however, for only about 80 feet up—and fills the whole space from

IN THE GRANITE GORGE ABOVE BRIGHT ANGEL. (Photo. 420.)

THE GRAND CANON BELOW THE GRANITE AND ABOVE KANAB. (Photo. 554.)

wall to wall. The walls of this portion of the Canon (and it comes nearer being a true canon than any other part of the river), rise above the water over 2,000 feet, and they are almost vertical, the benches are narrow, and the vertical cliffs between the benches higher than any other section. And yet, strange to relate, from one end of this section to the other there is a bench about 30 feet above high water, running almost parallel with the grade of the river, of solid marble, wide enough to build a four-track railway upon, and not interfere with the perpendicular walls above or the river below. (For illustration see Photographs Nos. 600 and 608.)

Immediately below this 20 mile stretch, the canon becomes wider and the river broader, and for about 10 miles to the great volcano, the canon with its wide river, broad high talus slopes and receding bench walls, is identical with that above the Kanab. (See Photograph No. 618.)

The appearance and form of the whole country changes a short distance above the volcano. From there, for a distance of some 40 miles everything has been torn and rended. The solid cliffs of marble which above stood up so grand are now in shreds. The former pinnacles and spires have tumbled and gone. Great vaults are seen where

[CONTINUED ON PAGE 353.]

The International Engineering Convention.

(*Continued from page* 321.)

To accommodate the varying tastes and desires of the visitors the Philadelphia Committee arranged eight different excursions for Monday, Oct. 6, visiting the chief points of engineering and metallurgical interest in Philadelphia and vicinity. The most popular of these was that given by the Philadelphia & Reading R. R. Co. up the Schuylkill valley to the works of the Phœnixville Iron Co., and the Phœnixville Bridge Co. Notwithstanding the pouring rain a party of about 175 took the excursion, and, under the guidance of Supt. BONZANO, of the Philadelphia & Reading, Mr. E. HENRY RONEY, of Philadelphia, and Mr. HUGH BELL, of the Iron and Steel Institute, a very pleasant day was spent.

It is probably not generally known that this year is the centennial of the establishment of the Phœnix Iron Works. In 1790 a rolling mill and nail mill run by water power was built on the site of the present works. The plant now covers an area of 70 acres. The largest building, containing the finishing rolls, covers an area of 6¼ acres under a single roof. It is 928 ft. long and 288 ft. wide between centers of columns. Among the things of special interest to the visitors were the Stow flexible shafts, attached to reamers for reaming punched holes, a wonderfully efficient and convenient tool, and the great 1,000-ton hydraulic testing machine for testing full size bridge members, on which have recently been broken eye bars of 10 ins. by 2 ins. cross section intended for the new bridge at Louisville, Ky.

Another operation which greatly interested the foreigners was the hydraulic upsetting machine for forming the heads on eye bars, a process little used abroad. The cold saw which cuts off a 70-lb. beam in 40 seconds also found many interesting spectators. Before leaving the party assembled in front of the main office, and Sir LOWTHIAN BELL tendered the thanks of the visitors to President REEVES, of the Phœnix Co., and his associates. All nationalities joined in giving three cheers to the courteous hosts, and took the train well satisfied with their first day's inspection of an American iron works.

The Baldwin Locomotive Works probably claimed the next largest number of visitors. Nothing excited more interest here than the enormous output of the works, which will build this year over 900 locomotives. At Wm. Sellers & Co.'s a pleased and interested group remained long about the tool grinding machine. The smooth finish of the castings here was an object of general comment. An industry which has no counterpart outside of the United States is A. Whitney & Sons' car-wheel works. That a car wheel could be made of cast iron and be safe and serviceable seemed a novel idea, to many of the visitors at least; and the contracting chill process, which was explained to the visitors, impressed them as a most ingenious invention.

Bement, Miles & Co.'s works had a number of visitors and the City Hall, United States mint, Independence Hall, and other points of historical interest attracted others. Small parties went to Wilmington, visiting the Edge Moor Bridge and Iron Works and the Harlan & Hollingsworth Car Works, and to Camden to R. D. Wood & Co.'s works.

The social event of the Philadelphia meeting was the reception at the Academy of Fine Arts on Monday evening. Almost every one of the foreigners were present, and they were met by about 700 Philadelphians, including especially those prominent in the manufacturing industries of eastern Pennsylvania, Messrs. Jos. D. POTTS, ECKLEY B. COXE and other members of the executive committee, with their wives, received the guests. An elegant lunch, fine music, and the cordiality of numerous Philadelphia girls, with distinguished Colonial ancestors, contributed to the enjoyment of the guests, and the evening's pleasure formed a fitting close to the Philadelphia sojourn.

THE CORNWALL IRON DISTRICT.

Tuesday morning was both foggy and rainy, but the weather did not injure the good temper of the excursionists. Three trains, each consisting of eight Pullman sleepers and two dining cars, drawn by two engines, awaited the party at Broad St. Station. The excursionists numbered 516, almost all of whom were from abroad. The programme for the day included a run over the Pennsylvania to Conewago, and thence over the Cornwall & Lebanon R. R. to the Cornwall ore banks. The heavy trains of Pullman coaches moved rather slowly, however, and the train was somewhat late in reaching the ore banks. The Cornwall ore deposit is the only one in the East of any magnitude which is free enough from phosphorus to be suitable for making Bessemer pig, with the exception of the Tilly Foster mine and one or two of the Champlain ores. The Cornwall ore contains about 50% of iron and about 5% of sulphur, and thus requires roasting to expel the sulphur before it is smelted.

The mines visited by the party are enormous open excavations in a high hill, and the ore is excavated at very small cost. The fates did not conspire to make this tour of inspection an interesting one. The rain had slackened somewhat, but there was still enough to keep the lady members of the party confined to the cars. The hour when the foreign guests are accustomed to a hearty midday meal was already long past. Nobody seemed to be able to see anything interesting, nor was the party in a mood to appreciate interesting things.

The passengers in the first section, those who had gone out to see the ore banks, returned to the train, which drew out on a lonely siding and stood motionless for an hour and over.

As the pangs of hunger began to gnaw the British and German iron masters, a dim suspicion seized them that this excursion might be a bold scheme on the part of the Pennsylvania manufacturers, in whose hands the party were, to strike a death blow at foreign competition by starving to death its principal leaders in the mountains of Pennsylvania. This was too grave an accusation to make in public, however, and none ventured to whisper his thoughts to his neighbor. Finally the train moved off, and every body plucked up courage again. At about half-past three Mt. Gretna Park was reached; the welcoming strains of a brass band greeted the party; it was found that those in the second and third sections had already been fed; and the famished passengers in the first section made all convenient haste to the dining pavilion, where through the courtesy of Mr. ROBERT H. COLEMAN a substantial lunch had been provided.

From Mt. Gretna Park a 2-ft. gauge railroad runs to the summit of Governor Dick Mountain. The time was too short for the whole trip, but a short run was made over the little road, around whose sharp curves the cars run with remarkable steadiness. The cars are open "observation" cars, with cross seats, and the locomotives are American type, exact copies of the standard passenger locomotives of the Cornwall & Lebanon R. R., except as to size.

From Mt. Gretna Park the train carried the party down to the Colebrook furnaces, also owned by Mr. COLEMAN. There are two furnaces here of modern build, with which the visitors seemed to be favorably impressed. The most novel thing about the plant are the gas furnaces for roasting the ore, which were built a year ago. Coal was formerly used for this purpose, but does not fully expel the sulphur from the interior of the ore lumps, leaving sometimes as much as 2¾%. With the gas-fired furnace the sulphur is very thoroughly expelled, sometimes to a percentage as low as $\frac{1}{10}$%.

A long stay was made at the furnaces, and then the excursionists returned to their trains, ate a hearty meal in the dining cars, and with long delays at Harrisburg and other points were drawn westward to Altoona, where they arrived in the early morning.

This record would lack completeness if no mention were made of the fact that at least nine-tenths of the foreigners had never before passed a night in a sleeping car. The few Americans in the party, with as much solemnity as possible, explained to the strangers how to disrobe, where to put their clothing and similar important details. The foreigners made valiant attempts to follow the instructions, but over their endeavors it is better, much better, that a veil should be drawn.

THE PENNSYLVANIA RAILROAD SHOPS.

When the excursionists awoke Wednesday morning their trains were standing on a siding opposite the new Juniata locomotive shops of the Pennsylvania Railroad at Altoona. By the time the first relay had breakfasted General Superintendent of Motive Power THEO. M. ELY and Dr. C. B. DUDLEY, head of the Department of Tests, were on hand with a numerous staff of assistants to escort the visitors through the shops. Each division of the party was taken first through the new locomotive shops, then by train to the car shops, from there by train to the old locomotive shops, and, as soon as the tour of these shops was concluded, to the Logan House dining room, where a luncheon was spread for the party by the courtesy of the Pennsylvania Railroad Co.

The new Juniata locomotive shops are practically completed; but much of the machinery has still to be placed in position. No pains has been spared in the design of these shops to secure the highest efficiency for the labor employed, and in the amount and variety of special machinery they will not be excelled by any locomotive works in the country. Space permits mention of only the chief features of the new shops. Perhaps the feature which most impresses an American is the general use of hydraulic machinery, especially in the boiler shop and blacksmith shop. Much of the hydraulic machinery is imported from Thos. Tweddell's Works at Manchester, England. Even the portable riveters are worked by hydraulic pressure. The shops are liberally supplied with overhead cranes, driven by electricity. Two of these, of 65 ft. span, in the erecting shop, will take the heaviest locomotive and move it to any part of the shop. The power plant for the shop consists chiefly of Westinghouse engines, furnished with steam by a battery of six horizontal tubular boilers, fired by Roney mechanical stokers. A large compound pump built by the Dunkirk, N. Y. Iron Works, working up to a pressure of 2,000 lbs supplies the hydraulic machinery. A battery of 8 gas producers, using anthracite coal, is to furnish gas to the heating furnaces.

The shops are heated by the Sturtevant blower system and supplied with lavatory accommodations for the workmen which are probably not excelled in any workshop in the country. Probably nothing astonished the foreigners more than this provision for the comfort of the employés. The buildings are substantial brick structures, with glass forming a large part of their walls, and the flooring in several of the shops is of asphalt paving blocks.

At the car works the passenger car paint shop forms by far the greatest innovation on usual practice. It is heated by the Sturtevant blower system, and a part of the air circulated through the heating coils is taken from the interior of the shop, thus economizing fuel. The proportion taken from the interior of the shop is varied according to the weather. The visitors found much else that was novel to them here, however. An amazed group gathered in the wood working shop about the bit which bores a square hole, and other high speed wood-cutting tools were viewed with great interest. A large party took a ride on the electric transfer table, and were greatly pleased with its working.

At the locomotive shops nothing seemed to excite more general interest than the car wheel foundry. The fragments of wheels broken up under the drop were carefully examined by the experts of the party, and some even ventured to express the opinion that English railways must at length come to use cast-iron wheels. The car wheel grinding machine was, of course, an entire novelty to the visitors, and the comments upon it were numerous.

THE BRITISH AND GERMAN METALLURGISTS AT PITTSBURG.

Besides the brief account of the first day's session of the Pittsburg International meeting published last week, we give elsewhere in this issue extracts from the address of Sir JAMES KITSON, at the opening of the meeting, outlining the contributions of British inventors to steel and iron metallurgy, accompanied by an interesting letter from Sir HENRY BESSEMER, describing the circumstances under which his great invention was made.

The great attraction for Thursday afternoon was an excursion to the Wildwood oil field over the Pittsburg & Western R. R., where oil and gas wells were seen in all stages of progress. A nitro-glycerine torpedo was exploded in one of the wells and the visitors had an opportunity to see, hear, and smell natural gas and crude oil to their heart's content.

Those who did not care to take the rather hard jaunt to Wildwood assembled at the Pittsburg Exposition grounds in the afternoon, and from that point were conducted in various directions by the guides. One party went by boat to see the Davis Island Dam and the Ohio Connecting Bridge, recently described and illustrated in ENGINEERING

NEWS. Three other parties went by trains: one to visit the new works of the Westinghouse Air Brake Co. at Wilmerding; the second, to the works of the Spang Steel & Iron Co. at Etna, and the third, up the Monongahela, on the Baltimore & Ohio, to visit a coal mine, and witness the Tesla electric motor applied to lighting, pumping, ventilating, and to driving coal cutters.

Of the firms whose works were visited in the city, only a list can be given. They were the Westinghouse Electric Co., the Sable Iron Works, Mackintosh, Hemphill & Co., Pittsburg Steel Casting Co. Park Bros. & Co., Carbon Iron Co., Pittsburg Reduction Co., Kensington Iron Works, Soho Iron Mills, Linden Steel Co., Singer, Nimick & Co., Pittsburg Iron Works, Oliver Iron & Steel Co., Oliver & Roberts Wire Co., Jones & Loughlin, La Belle Steel Works, and the power plant of the Citizens' Traction Co.

On Thursday evening a reception was given in honor of the guests at the Duquesne Club. The hours named in the cards of invitation were from 8 to 11; but actually the festivities lasted from 9 till 2 A. M.

SECOND DAY OF THE INTERNATIONAL MEETING.

The concluding session on Friday morning was called to order by Mr. ALEXANDER THIELEN, who, on behalf of the 142 German visitors, expressed thanks for Pittsburg's hospitality. He said it was no pleasure trip on which the party had come, but to acquire knowledge of American progress and methods; and declared that American mechanical devices far surpassed those of Germany.

Secretary R. W. RAYMOND, of the American Institute of Mining Engineers, paid a glowing tribute to the genius of RITTER VON TUNNER, calling him the Nestor of metallurgical science. As this second day of the International meeting was the one on which the school at Leoben, Germany, which TUNNER founded, celebrated its fiftieth anniversary, he proposed that a cablegram should be sent as follows: "The International Session of German, British and American engineers and metallurgists sends greeting to TUNNER and Leoben."

Secretary RAYMOND also read a letter from Dr. T. STERRY HUNT, Past President of the American Institute of Mining Engineers, who was associated with VON TUNNER on the jury of awards at the Expositions of 1855 and 1876, warmly commending the personal character and scientific attainments of the great metallurgist. The motion of Secretary RAYMOND was seconded with appropriate remarks by Sir LOWTHIAN BELL and FREDERICK SIEMENS, and was carried unanimously by a rising vote. It was also voted that messages be sent to the near relatives of BRUNER, WM. SIEMENS, HOLLEY, PERCY and ADAMSON, expressing the appreciation by the metallurgists of three nations of the contributions of these men to metallurgical science.

A paper was then presented by Dr. HERMAN WEDDING, of Berlin, on "The Progress of German Practice in the Metallurgy of Iron and Steel since 1876, with Special Reference to the Basic Process." The paper was a lengthy and exhaustive one, whose scope is well indicated by its title. One portion of the paper was devoted to the Mannesman process for rolling tubes from a solid bar, described in ENGINEERING NEWS, Aug. 2, 1890. To illustrate this part of the paper, a great variety of tubes made by the Mannesman process were on the platform of sizes from 1 in. up to 8 ins. in diameter, made in various shapes. This interesting exhibit was presented at the close of the meeting to the Engineers' Society of Western Pennsylvania.

Vice-President HENRY M. HOWE, of the American Institute of Mining Engineers, then took the chair, and Mr. THIELEN read a paper on "The Recarburization of Steel with Pure Carbon," which we reprint with editorial comment.

The paper announced on "Transportation as an Element in the Iron and Steel Manufacture, by WM. P. SHINN, was not presented, but it will be printed and distributed later. The paper by Dr. T. STERRY HUNT on "The Iron Ores of the United States" was read by title only in the absence of its author, and the remainder of the time was devoted to the paper by Prof. JOHN W. LANGLEY, on "International Standards for the Analysis of Iron and Steel." This paper referred to the methods in use for the determination of carbon in iron and steel by double chloride solutions, and showed that these methods had led to considerable inaccuracy. The process recommended in their place was the combustion of the carbon in pure oxygen which though a very tedious method the author believed to be more reliable. An animated discussion was carried on by Dr. J. B. DUDLEY, EDWARD RILEY and others on the paper. The last paper of the session was one on "Aerial Wire Ropeways,' by J. POHLIG, of Cologne, Germany, which was postponed from the New York meeting. The system of cable transport employed by the author is that of OTTO, which is similar to the Bleichert cable transport system extensively used in this country.

Before the meeting closed Sir JAMES KITSON appeared on the stage and offered a resolution expressing for the Iron and Steel Institute great appreciation of the hospitalities received in Pittsburg. The resolution was seconded by Mr. THIELEN on behalf of the German society, and the vote was carried by three British Hurrahs, followed by three German Hochs.

UP THE MONONGAHELA.

At Philadelphia the excursionists had been carried down the Delaware River in the *Columbia*. The boat which took the party on the excursion to the Edgar Thomson steel works on Saturday afternoon was christened the *Mayflower*, but she bore no resemblance to her historic namesake, save that she was able to transport a much too crowded party to their desired haven. Her great splashing stern wheel and her smoke stacks, which turned down to pass under bridges and poured forth great volumes of black soot and cinders upon all nationalities alike, were observed with great interest by the foreigners. The 12-mile trip up the river was a magnificent one, for it was a perfect autumn afternoon and the great manufactories which were passed and the vivid foliage which cover the bluffs pleased and interested all.

At Braddock the party disembarked, while the local cornet band welcomed the visitors with various patriotic selections. With the exception of the Illinois Steel Co.'s works the Edgar Thomson works is the only plant in this country in which the melted metal from the blast furnace is run into the Bessemer converter direct, thus saving remelting. The plant consists of 9 blast furnaces, 4 Bessemer converters with cupolas and heating furnaces, a blooming mill and a rail mill. The two newest blast furnaces, erected this year, are perhaps the best equipped in the world and are making very nearly as good a record as furnace No. 7 of this plant, whose magnificent performance, described by Mr. JAS. GAYLEY at the opening session of the Iron and Steel Institute, so astonished the visitors from abroad. The annual capacity of the blast furnace plant is about 600,000 tons.

In the steel department the ingot as soon as it enters the blooming mill moves continuously forward, halting only once for a slight reheating, until it is slid off at the terminus as a complete rail. The machinery for charging and drawing the blooms from the heating furnace received much praise from the visitors.

Before the tour of the works was finished it began to rain, and this somewhat interfered with the visit to the Homestead Steel Works of Carnegie, Phipps & Co., where the next stop was made. The steel making plant here comprises two Bessemer converters and eight open-hearth furnaces, while eight more are nearly ready for use. The other equipment includes a blooming mill, two mills for structural iron, a 32-in. slabbing mill, and a 119-in. plate mill. The annual product now comprises about 35,000 tons of steel plate and 115,000 tons of structural steel, etc. The Darby process of recarburizing with solid carbon is in use at seven of the open-hearth furnaces.

PERSONALS.

Mr. MARTIN ALLEN, Superintendent of Section 3 of the Erie Canal, died at Amsterdam, N. Y., on Oct. 8.

Mr. CHAS. A. ALLEN, City Engineer of Worcester, Mass., has been engaged to report on the Woonsocket R. I., sewerage system.

Mr. T. C. EGGLESTON, M. Am. Soc. C. E. and Mr. W. F. DENNIS, M. Am. Soc. C. E., have opened an office in the Shafer Building, Richmond, Va., for all classes of engineering work.

Mr. G. M. BAILEY died recently at his home in Yonkers, N. Y. He was for several years Assistant Manager of the Manhattan Elevated Ry., and was considered a very valuable officer.

Mr. S. F. BALCOM, of the engineering staff of the Illinois Central R. R., has been appointed Division Engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry., with headquarters at Indianapolis.

Mr. ROBERT BLICKENSDERFER, who resigned his position as Superintendent of the Nebraska Division of the Union Pacific Ry., about 2 years ago, has been requested to again take the office in place of Mr. J. M. BARR, resigned.

General Manager J. M. FERRIS, of the Kanawha & Michigan Ry., has appointed the following officers: Mr. T. M. PEDAR, General Superintendent; Mr. CLIFFORD BAXTON, Chief Engineer, Mr. J. B. MORGAN, Master Mechanic.

Mr. THOMAS FRANKLIN HOXSEY died Oct. 12 in Paterson, N. J. He was born in 1841. His work was chiefly connected in railroad and municipal engineering. For the past 4 years, he was engaged as Superintendent of the East Jersey Water Co.

Mr. HENRY F. JENKS, inventor of the Jenks drilling and tapping device, park hydrants and many other specialties in that line, is the subject of a long and interesting biographical sketch in the Rhode Island *Military Journal* of September. He is Past Commander of the Rhode Island G. A. R.

Mr. ALEXANDER SUTHERLAND died suddenly at his home in South Amboy, N. J., Oct. 13. He had been in the railroad business for 25 years, first in the employ of the Camden & Amboy R. R. and later of the Pennsylvania Co. For some time he was Superintendent of the Amboy division of the latter company, and when he died he was General Freight Agent of the same division.

Mr. THOMAS F. HORSEY died at his home in Paterson, N. J., on Oct. 14, of inflammation of the stomach. Mr. HORSEY was born in Paterson, March 5, 1841. He began business as a contractor by building the upper reservoir of the Passaic water-works and laying the pipes under the Passaic River. He also built the Midland Railway from Hawthorne to Hackensack. In 1886 he became the manager of the famous New Jersey water syndicate, which now owns large tracts of land in Northern New Jersey.

Mr. ROBERT GORDON, M. I. C. E. and M. Am. Soc. C. E., has resigned his position as Government Engineer of Siam, and will shortly return to England. Mr. GORDON is well known among American engineers, and, though he he was for 17 years the Resident Engineer of Burmah, he is a strong advocate of American methods of railway construction and equipment in the East. His departure from Siam would seem to mean that that country is not yet yet ready for railways, and that the 300 miles of line favored by the King is not to be built at present. Later information seems to indicate that German engineers and German contractors have captured the King of Siam and propose to build the first 100 miles of railway in that country.

Mr. RICHARD N. ALLEN, inventor of the paper car wheel, was buried in Springfield, Mass., on Oct. 10. Mr. ALLEN was born in Springfield in 1827; was a railroad engineer for a time on Connecticut and Ohio railways. About 1854 he was master mechanic on the northern division of the Cleveland & Toledo R. R. and later occupied similar positions on the New Orleans & Jacksonville R. R. and Memphis & Ohio R. R. About the close of the civil war Mr. ALLEN returned to Cleveland and devoted himself to his inventions. His interest in a straw-board mill at Pittsford, Vt., owned by himself and brother-in-law, turned his attention to car wheels made of compressed paper. It was a long time before he could get his inventions tried; but GEORGE N. PULLMAN finally saw it, became interested, and the Allen paper car wheel factories of Hudson, N. Y., and Pullman, Ill., were started, and fame and fortune were secured.

NEW PUBLICATIONS.

—*Reprint of letters written in America representing the progress and prospects of Middlesborough and Cumberland Gap.* Published by the Board of Directors, Middlesborough Town Co., London, Eng.; pamph., 8¼ × 14, pp. 48, illustrated.

—*Report of Consulting Engineer* (JAMES D. SCHUYLER) *on the Pampo Water Co. of San Diego Co., Cal.*, July, 1890. Pamph., 3½ × 6 ins., pp. 18.

This report considers in some detail the construction of a rock-fill dam and large reservoir and a diverting dam, a long and several shorter conduits, all by the above company, for irrigating purposes and for the supply of towns. The estimated cost of the whole project is $1,760,000, or, if a distributing system be laid in San Diego, $2,250,000. The report will receive further notice in a future issue.

—*Report of the Special Committee Appointed to Devise a Plan for the Improvement of the Water Service* of Concord, N. H. May, 1890. Paper, 8vo. pp. 18.

This is really a report of Consulting Engineer PERCY M. BLAKE, who reviews the general condition and needs of the water-works, and recommends the construction o

a new pumping station, equipped with a high duty pumping engine and appurtenances, the laying of about 14,000 ft. of 12 to 16-in. mains and the construction of a 1,500,000-gall. reservoir. The estimated cost of these improvements is about $91,000.

SOCIETY PROCEEDINGS.

Technisher Verein von New York.—At the annual meeting, held Oct. 11, the following officers were elected: Prest., PAUL GOEPEL; Vice-Pres., E. L. HEUSNER; Corresponding Sec'y, M. C. BUDELL; Recording Sec'y, HEINRICK SCHREITER; Treasurer, CHAS. HEINECKE; Librarian, F. KNAUER. The chairmen of the various sections are as follows: Civil engineering, G. SCHENCK; mechanical engineering, H. B. ROELKER; architecture, H. W. FABIAN; chemistry and metallurgy, Dr. J. KRIEGER; electricity, M. FEILBOGEN. The society now numbers 244 members.

American Society of Civil Engineers.—Regular meeting of Oct. 15, at the house of the Society, Vice-President A. FTELEY presiding. A paper on "Steam Heating" was read by Past President W. E. WORTHEN. This was an interesting historical sketch of heating by hot water and steam as used in this country, and concluded with a description of the heating with exhaust steam of the mills of the Merrimack Manufacturing Co., at Lowell, Mass. These mills, covering 20 acres, are heated from a single point by a system of steam and exhaust pipes, carried on posts and protected by the Ober jacketing, made of mineral wool. The efficiency of this jacketing, in the very small amount of heat escaping, was proven by a photograph showing snow lying unmelted on these protected steam pipes. Mr. WORTHEN thought that a similar circulating heating system could be often used to advantage in our large cities, and suggested the elevated railways as providing means for supporting the pipes. He had also proposed, in the early history of steam heating in this city, a system of conduits carrying not only the proper steam pipes but also high-pressure water mains, gas, etc. At the conclusion of the paper Past President FRANCIS and Messrs. EMERY, BALDWIN, BRINCKERHOFF, WHITE and others took part in the discussion. Considerable talk followed on water and grease traps, and their efficiency and design, as essential features of the use of exhaust steam for heating.

American Street Railway Association.—The ninth annual meeting of the association began its session at Buffalo, N. Y., Oct. 15. The attendance was large, and included many men well known in street railway and electrical circles. The subjects discussed during the day were: "A Perfect Street Railway Horse," "A Year's Progress of Cable Motive Power," "Electric Motive Power Technically considered," "Novel Scheme for the Development of Street Railways," and "Public and State Treatments of Corporations." The supply men were well represented, the following well-known firms having exhibits:

Chadbourne, Hazleton & Co., Philadelphia; Bickford & Francis Belting Co., Buffalo; William Sewell, New York; A. Whitney & Son, Boston; R. T. White, New York; Gibbon Duplex Railroad Track Co., New York; Conecticut Motor Co., Plantsville, Conn.; Morton Safe Heating Co., New York; Okonite Co., New York; Michigan Stove Co., Detroit; Berlin Iron Bridge Co., East Berlin, Conn.; Fulton Foundry Co., Cleveland; Emmett Bros., New York; James Spear Stove & Heating Co., Philadelphia; Christopher Track Clearer Co., Baltimore; Hale & Kilburn Manufacturing Co., Philadelphia; Hathaway & Robinson, Cleveland; J. G. Brill Car Co., Philadelphia; Edison General Electrical Co., New York; Pratt & Letchworth, Buffalo; New York Car Wheel Co., Buffalo.

The exhibits consisted principally of special street car oppliances, and were generally very creditable; the most notable being those of the North American Construction Co., representing the Westinghouse people, the Edison General Electrical Co., and the Thomson-Houston Electrical Co. The street railway car for the Short Line Ry. Co., of Cleveland, O., exhibited by the last-mentioned company was an especially fine example of artistic work in this line.

New England Railroad Club.—Meeting of Oct. 9, President RICHARDS in the chair. The President announced as the subject for discussion at the next monthly meeting, "The Economy and Safety of Swing-motion Trucks as compared with Rigid Trucks," and the subject for the present occasion, "Steel-tired Wheels, Method of Equalizing their Wear, and Machinery for Turning them off," to be opened by Mr. J. N. LAUDER, of the Old Colony R. R.

Mr. LAUDER: In the matter of driving wheels it is not perhaps necessary to say anything, since it has become the universal practice in this country to use steel tires on driving wheel centers. The time was when driving wheel tires were used made largely of chilled cast iron, but the steel tires have driven them entirely out of use.

As regards engine-truck wheels, tender and car wheels, the practice of using steel tires has not become universal, and probably never will in this country, on account of the additional cost of running steel-tired wheels over the cost of running chilled cast iron wheels. I think there is no question that it costs more per mile to run the former in any kind of service, than the latter, with the possible exception of some very long through runs, such as are made by the Pullman and Wagner cars, running between points East and West, as between Chicago and the Pacific coast. In that case I think the cost per mile would figure as low with steel-tired wheels as with chilled iron wheels, because the wheels are worn out so much more rapidly than those in use on local trains that the item of interest on the money invested does not count much. For all ordinary purposes the chilled wheel undoubtedly is very much cheaper to run the rolling stock on than any steel-tired wheel that has yet been made. The reason that steel-tired wheels are coming more largely into use, notwithstanding their cost, is because there is more safety in their use, it is generally supposed. When we consider how many hundreds of thousands, perhaps millions, of chilled wheels are run at the present time all over the United States, we find that the percentage of breakages is so small as to be hardly worth considering; but once in a while a chilled wheel breaks; while on the other hand, allowing that the steel-tired wheel, is no safer than the chilled wheel, if the train is derailed by a broken steel-tired wheel, the road stands much better before the public, the commissioner and the courts than if they had used the cheaper wheel, because it can truthfully say it has used the best known wheel without regard to price.

My chief objection to solid steel wheels, allowing that we get the mileage out of it that we do out of other wheels, is that it is almost impossible to detect defects that may exist in the structure of the wheel during manufacture, much more difficult than in the making of cast iron wheels, and until the makers can overcome this difficulty they will have up-hill work in introducing their wheels. We all know the importance of having every wheel absolutely sound.

In regard to the maintenance of the steel-tired wheel, any means that can be devised to prolong the time between turnings, and at the same time keep the tire in reasonably good condition for service, is a step in the right direction. I have to say some rather complimentary things in reference to the so-called Ross shoe. We have used this shoe for several years on our road, and we have come to the point where I am quite enthusiastic over its performance. The shoes furnished some years ago had a detrimental effect. I had some tires badly cut by the so-called Ross-Meehan shoe, which is a shoe with some steel slugs in the face of it. The object was to keep the tire worn down outside, where it rests on the rail, to wear it as fast as the rail wears it, and also to wear down the flange as fast as the rail wears the tread. But my observation is that the Ross-Meehan shoe, especially in suburban service, where there is much braking, wears the tread of the wheel faster than the rail wears it, making the tire imperfect in a short time, and to some degree dangerous. To obviate that difficulty, we have used the shoe without the slugs, i. e. the plain Ross shoe, made of good quality of cast iron. That shoe, in all local service where the brakes are applied quite often, seems to just about keep the wear of the tire uniform over its whole face. I have recently removed the tires of 42 in. wheels that have made 144,000 miles between the first and second turning; up to the first turning they had made 44,000. This was perhaps not all due to the Ross shoe, but largely due to it. It makes the tire wear longer than the plain shoe, because it does not touch the tire where the rail touches it; of course a tire wears out faster where it has the abrasion of the rail and also of the brakes in the same place. The Ross shoe is the only device that I know of that will prolong the life of the tire and give it qualities that will keep it in use much longer between turnings. This form of shoe has another quality that I am at a loss to account for, and that is, it seems to keep the flanges from cutting, from getting sharp. This may perhaps be explained in part by the fact that the ordinary plain shoe might be hung in such a way as to have a tendency to sharpen the flange, while the Ross shoe is held in position by locking over the flange, so it will not have that effect.

As for truing up the tires when they become worn out of shape, we are familiar with the four or five different designs of car-wheel turning lathes. They are all based I think, practically on one principle; I think they are all patterned from the original lathe that Mr. Washburn designed at Holliston, and have the same underlying elements that that machine had. I think the first one was designed by Mr. Miles, of Dement & Miles. We have heard some pretty wild statements as to the capacity of different lathes. I have heard it insisted upon that in 10 hours' time six pairs of wheels could be turned; that the average was four pairs per day. I cannot get any such service out of my machines; I have three of different manufacture, and think they do well if they turn two pairs of 42-in. wheels in a day.

Mr. MARDEN: We have been using steel-tired wheels, to a certain extent, since 1881, and we are now equipping the balance of our passenger cars with those wheels. Of all the wheels put under since 1881, I think we have removed but one pair for being worn out, and that pair made 390,000 miles, if I remember right. We made a comparison between certain chilled wheels and steel-tired wheels, and took the average to satisfy ourselves as to the cost of running each kind, and if I remember correctly the balance was very slightly in favor of the steel-tired wheel; they were very nearly equal. But there is another thing in favor of the steel-tired wheel which we consider worth considerable money to us, and that is that the cars can run a longer time between the times of turning the tires; cars with chilled wheels are constantly in the shop. I believe I get a larger mileage by turning off wheels every 50,000 miles, if they commence to sharp flange, than by letting them run as long as they will run safely. We have one of the Niles lathes that was guaranteed to turn off a minimum of four pairs of wheels per day; but I do not think we average more than two and a half pairs of wheels per day.

Mr. SNOW, of the Ramapo Works, Mr. LAUDER, Mr. ADAMS, and others, discussed at some length the merits of the Ross-Meehan shoes, agreeing substantially with the above.

Mr. MARDEN: We have found in our experiments with the Ross-Meehan shoe that there is less wear and cutting upon wheels of larger diameter than upon those of small diameter. I think to make a success of the Ross-Meehan shoe for passenger service, and perhaps it would be better for the Ross shoe also, it ought to be hung on a pivot, so that the brake should have a lateral motion, and adapt itself to curves, so that it can be brought square up against the wheel and not cut either way on the flange of the wheel.

Mr. SNOW: Such a device was put into use in Chicago two years ago, and has given excellent results.

Mr. CLARK: Do you believe the Ross shoe cuts more on small wheels than large ones?

Mr. MARDEN: From my observation I find it so.

Mr. CLARK: Don't you think it is due to the friction and velocity, the greater heating tendency, the burning of the two metals together?

Mr. MARDEN: I don't think so much is due to that. think there is something in favor of the locomotive tire in the fact that it does not have the brakes applied so much as on passenger cars.

Mr. CLARK: I represent the Niles Tool Works of Ohio, I have taken interest in the turning of steel-tired wheels and built a good many machines that are working in various parts of the country. We have a great variety of reports in regard to the capacity of the lathe for turning out work, one man saying it will do three times as much as another man. I think the lowest average that has been spoken of is 2½ to 3 pairs of wheels in 10 hours. The lathes are used by the Pullman Co almost exclusively and they turn out 2½ to 3 pairs a day. The main feature of our present lathe is supporting on the journal instead of supporting on centers. Many of the Western roads have adopted them, but I think the Boston & Maine is the only road in this section that has one.

The PRESIDENT: I did my best to have a representative of the Miltimore machine here, but failed. That machine lies dormant at present on account of legal and financial difficulties. The idea is this: Take a circular plate of ordinary iron, without teeth, and run it at high speed, and it will cut off any metal that can be brought to it. There seems to be little difference between cutting a piece of wrought iron and a file, which, you know, is one of the hardest of things. The same principle is applied in the cutting of I-beams, which have been cut in that way for several years. Miltimore's invention was in adapting the machine to the cutting of wheels. The car wheel is made to revolve very slowly, say three or four times a minute, and the blank wheel of the machine, which revolves 2,000 times a minute, comes in contact with it and wipes the metal off, as it were. The difference between turning off wheels of different hardness is not apparent. I saw a wheel badly worn put into the grinder, and in 12 minutes the wheel was made perfect in every way. A chilled wheel is turned as rapidly as a steel wheel. If a wheel is badly worn they pass it round several times; if slightly worn one revolution completes it. It seems to me that in a good machine of that kind there would be no difficulty in turning off 30 pairs of wheels a day.

Mr. COUGHLAN: I disagree entirely with Mr. LAUDER as to the economy in using chilled wheels as compared with steel-tired wheels. It has been demonstrated that there is a saving to the road with which I am connected of 25% to 30% by using steel wheels under passenger cars. I have never been able to get more than an average of 25,000 miles out of chilled wheels during the 15 years I have been upon the road. I have used six pairs of chilled iron 30-in. wheels to one turning of steel wheels on the same truck and on the same service, taking the wheels just as they came. Safety and economy are on the side of steel wheels. With regard to the Ross-Meehan shoe, I have found that it never injured the wheels until the shoe itself was partly worn through, and then the steel piece which is cast in begins to work round and get loose, and the cutting commences, but not till then. That trouble became so frequent we abandoned that shoe. The Ross has given very good and satisfactory results. We are obtaining very satisfactory results from the use of a solid steel wheel; we have about a hundred of them in use now. I think the reason why the chilled iron wheels suffer more by sliding than the steel wheels is that in producing the extreme hardness of wheels by the chilling process the adhesion is entirely destroyed, and therefore the wheels will slide; whereas with a medium hard, tough wheel the adhesion is retained. The latter will also wear away gradually, while the former will crumble away rather than wear like the other.

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COMING TECHNICAL MEETINGS.

Western Railway Club.—Next meeting, Oct. 21. Rooms, Phenix Building, Chicago. Secy., W. D. Crosman, 816 Rookery, Bldg.

Engineers' Society of Western Pennsylvania.—Next meeting, Oct. 21. Secy., S. M. Wickersham, Pittsburg, Pa.

Engineers' Club of Philadelphia.—Next meeting, Nov. 1. Secy., Howard Murphy, 1122 Girard St.

Civil Engineers' Society of St. Paul.—Next meeting, Nov. 3. Secy., G. L. Wilson.

Western Society of Engineers.—Next meeting, Nov. 4. Secy., J. W. Weston, 230 La Salle St., Chicago.

Civil Engineers' Club of Cleveland.—Next meeting, Nov. 4. Secy., C. O. Palmer, 29 Cedar Ave.

Engineers' Club of St. Louis.—Next meeting, Nov 5. Secy., W. H. Bryan, 30 South 7th St.

American Society of Civil Engineers.—Next meeting Nov. 5. Secy., John Bogart, 127 E. 23d St., New York.

Civil Engineers' Association of Kansas.—Next meeting, Nov. 5. Secy., J. C. Herring, Wichita, Kan.

Association of Civil Engineers of Dallas.—Next meeting, Nov. 7. Secy., E. K. Smoot, Elm and Austin Sts.

Technical Society of the Pacific Coast.—Next meeting Nov. 7. Secy., O. von Geldern, 408 California St., San Francisco.

Engineering Association of the Southwest.—Next meeting, Nov. 18. Secy., Olin H. Landreth, Vanderbilt University, Nashville, Tenn.

Boston Society of Civil Engineers. Next meeting, Nov. 19. Secy, S. E. Tinkham.

New York Railway Club.—Next meeting, Nov. 20. Rooms, 118 Liberty St.

Engineers' Club of Cincinnati.—Next meeting, Nov. 20. Secy., J. F. Wilson.

WE learn from the M. C. B. committee on standard couplers that their request, published in our issue of Sept. 17, that manufacturers should send a sample coupler with drawing or blue print to Mr. E. CHAMBERLAIN, N. Y. C. & H. R. R., Buffalo, N. Y., has not as yet been very generally complied with. It is so obviously for the interest of every manufacturer who desires to have a standing as manufacturing the M. C. B. coupler that he should send in a coupler and drawing as requested, that we again call attention to the matter, to the end that all couplers in the market may be represented in the committee's report.

THE Mannesmann tube exhibit at the Pittsburg meeting was certainly one of its most interesting features. In our issue of Aug. 2 we described and illustrated the remarkable process by which these tubes are manufactured, which is certainly one of the most striking and impressive examples of the "scientific use of the imagination." The tubes, it will be remembered, are expanded from solid bars into hollow tubes by exterior pressure, leaving a vacuum within when the ends are left closed. At Pittsburg some of the massive tubes had been broken in two to show the nature of the material. The interior surface has a crystalline, metallic luster, showing at once that it was not formed over a mandrel, nor by any ordinary process of manufacture. Tubes of almost any size and length can be formed by the process, and their immense strength was indicated by many samples, one tube having been expanded threefold on a conical mandrel, others having been turned inside out or tied in a knot, treatment which no tube made by any other process could be expected to stand, as we hardly need say. The process is still so young that it is difficult to say what possibilities it may have; but among the uses to which it is expected with much reason to apply it in future, with great advantage, are seamless boiler tubes and barrels, and especially long weldless steel tubes for compression members of bridges; in which last respect it may prove especially useful, since the process admits of leaving solid metal at the ends for connections, besides its other advantages. The 4-in. pipes now being furnished for an oil pipe line in the Caucasus are required to test up to 2,500 per sq. in., which they do easily. The available range of size and thickness is already great. As a whole, it is evident that a new product has come upon us, of capabilities as yet imperfectly determined, and probably as yet undeveloped.

A SIMPLE, common sense solution of the railway rate-cutting problem was suggested by Chairman WALKER of the Interstate Commerce Railway Association, at Chicago this week. It is not necessary to refer here to the many fraudulent devices daily put into practice by agents for securing freight and traffic for their roads, or to the many disgraceful schemes that now masquerade under the name of "business competition;" every one knows of these for himself. But every one, even the competing managers of railways, will also admit that the present policy is more or less suicidal and that it would be better for all if it could be generally and permanently stopped. But it must be stopped all along the line to be efficient or of any value, and this Chairman WALKER proposes to accomplish by a joint agency plan, the fundamental principles of which are stated in the following language:

> "Separate wholly the competitive from the local or non-competitive business of the roads and place joint agents at all competitive points, whose jurisdiction shall extend over all competitive business originating within the territory for which one common rate is charged. Agree upon a basis for the guidance of the agent at each point in a division of the business, that due justice may be done to all lines participating."

This plan is a simple one, and would close the doors to all effort to break down rates, if honestly carried out. If these joint agents were only executive officers, required to strictly carry out such instructions as might be from time to time given them by one central commission representing all the interests involved, a great step would be gained towards a just and equitable distribution of traffic. All the trouble now lies in the discretionary power of local agents who are commissioned to get business for their individual roads, "honestly, if you can, but get business." These men must be shorn of their present power before any permanent good can come, and the plan proposed for lodging this power solely in the executive officers of the road seems to be the only way out of the difficulty. No road should demand or receive more than its fair share of business; anything in excess of this can only be secured through injustice to others, and the only proper adjustment of each interest can be provided for in a general congress of all interests. The plan has its inherent difficulties in the possible predominating influence of some one road in a section more powerful than the others combined; and the success of any such new departure will depend upon the honesty with which its terms are carried out. But it is worth trying, in the interest of both the public and of the railways themselves.

IN the multitude of more or less absurd plans for perpetuating the memory of COLUMBUS, the guiding rule of each new projector seems to be to produce something "bigger," more outré in design and more generally useless than anything the world has, fortunately, ever before seen proposed for a similar purpose. If it should be deemed proper and wise for the people of the United States to build a monument to a man who never saw its territory, and who had practically nothing whatever to do with its present prosperity and standing among nations, there are other and more graceful ways of doing it than by erecting, for example, a Jumbo copy of the globe surmounted by a ship—that on the same scale would be 1,000 miles long. The two millions of dollars suggested as the probable cost of several of these so-called monuments could be devoted to purposes that would keep green the memory of the famous Genoese for many generations, instead of for the year or two of an International Exhibition. For one thing, that sum would build and amply endow a Columbus Historical Museum, or an institution devoted to the gathering and preservation of all that pertains to the early history of this country, in the way of books, maps, pamphlets and relics relating to that period. In many ways such an institution could be made useful now and to coming generations of Americans, for every year proves that something new is yet to be learned regarding the original discovery and earlier history of the New World.

The objection that would at once be made to any such scheme as that here outlined is that it would not pay commercially; in other words, it would not attract the masses. The fact is that with the projectors, who are now clamoring "to honor his memory," the name of COLUMBUS is being used merely as a bit of sentimental capital, with the hope of attracting by this means national attention and public capital to what should be practically a private enterprise, if it had any existence at all. The Eiffel tower perpetuates the name of its engineer, and it made money for those who built it. But it was a gracefully conceived structure in the first place, and from the very start had a definite financial purpose to fill, and it filled it well. There was no sham about it, and if the promoters of the World's Fair of 1892 really wish to combine a structural novelty with a profitable attraction, they should follow the example of the French more closely in honestly stating their purpose and by securing an engineer of experience and reputation to carry out this purpose.

Recent Developments in Steel-Making.

In his speech of welcome to the British and German iron masters at Chickering Hall three weeks ago Mr. ANDREW CARNEGIE rightly said that most of the works which America had to show in the iron and steel industry were but the development of foreign inventions. It is a development, indeed, which has far surpassed what has been accomplished in the country of their birth, as we pointed out in our issue of Oct. 4, and has been made plainly apparent in the excursion through the great iron-producing State of Pennsylvania. And while American engineers and metallurgists can lay claim to no such great inventions as those of

BESSEMER, SIEMENS or THOMAS, so far as iron and steel are concerned, yet they are entitled to great praise for the brilliant original work they have done in perfecting and applying these various processes, securing thereby a commercial efficiency which seems to be unequalled abroad.

The latest great foreign invention in metallurgy is described elsewhere in this issue in a paper by Dr. ALEXANDER THIELEN, read at the recent Pittsburg international meeting of metallurgical societies, and the invention seems to have such great possibilities of development in this country as well as abroad that it deserves a few words of comment.

It is well known that the steel produced by the Bessemer converter or the open-hearth furnace is not suitable for the finer uses to which steel is put. For cutlery, tools, and all the severer uses, crucible steel made in the old way is still the sole reliance. The products of the Bessemer converter and the Siemens furnace have taken the place of wrought and cast iron and have found employment in a multitude of new situations, but they have hardly come into competition with the steel made by the crucible process.

The reason why the steel produced by these modern processes will not make a good edge tool and will break under a much less strain than crucible steel lies in its composition. For one thing it has generally too low a percentage of carbon; but the most important hindrance is the considerable percentage of phosphorus which metal contains.

It is indeed a strange thing how the presence or absence of a few fossil animal remains in a bed of iron ore should so affect the whole character of the metal produced from it. The famous iron mines of the world are those whose product is freest from phosphorus. Witness the Swedish and Norwegian ores and their products. The general effect of phosphorus on iron, as every one knows, is to make the metal brittle at ordinary temperatures. Make a tool of steel from a Bessemer converter, and it will not hold an edge. The metal has too much phosphorus.

The ordinary Bessemer converter or the open-hearth furnace, as is also well known, do not remove any phosphorus from the metal in converting it from cast iron into steel. Hence only ores like the Lake Superior or the Cornwall, which contain originally very moderate amounts of phosphorus, can be used to make steel by these processes.

But by the basic or Thomas-Gilchrist process of steel making, in which the open-hearth furnace or the Bessemer converter is lined with a material basic in its chemical composition, the phosphorus is removed from the metal along with the carbon and silicon in the steel-making process, and so a pig iron containing considerable phosphorus can be used.

The ease and cheapness with which the Lake Superior ores have been turned into steel in this country have delayed any general use of the basic process here. England and Germany, however—especially the latter—are not so well supplied with ores free from phosphorus, and in consequence the basic process has rapidly come into use there. It should be said that other reasons besides the above are said to have delayed its introduction into the United States.

The opening up of the vast iron fields of the South, however, where pig iron can be made with wonderful cheapness, has called renewed attention to the basic process in this country. All, or nearly all, the Southern ores contain too much phosphorus to make steel, unless the phosphorus is eliminated. Moreover, the product of Southern blast furnaces promises to be greater than the demand for mill and foundry iron can absorb; and to find a market for their product Southern iron men are looking to the basic process.

Now, by the basic process it is possible to produce from a pig iron containing, say, 1½ per cent. of phosphorus a steel containing as low as .001 per cent. of phosphorus, or a percentage as low as that of the finest irons and steels in the world. It only needs the addition of a small percentage of carbon to become equal to crucible steel, so far, at least, as our present knowledge indicates.

In the familiar process of Bessemer or open-hearth steel making, whether acid or basic, the carbon is burnt pretty well out of the metal and the molten iron is then recarburized by the addition of spiegeleisen and ferromanganese; but by this method of carburization the percentage of carbon is still far below what is needed to make tool steel. Moreover, the manganese and other constituents added may exercise a somewhat deleterious effect on the metal. In the process elsewhere described by Mr. THIELEN, the carbon is added to the molten metal in the simplest manner possible, by allowing a stream of powdered coke to flow into the casting ladle along with the molten metal from the converter or furnace. Even solid steel absorbs carbon when heated to a white heat, as in the crucible steel process; and it is found that liquid steel takes it up almost instantly.

At the Phœnix works, at Ruhrort, Prussia, of which Mr. THIELEN is General Manager, this process has already displaced the use of spiegeleisen; and it is also finding favor in England. The process has been experimented with at both the Edgar Thomson works and the Homestead works, and at the latter place it is now in use to carburize the product of the seven basic open-hearth furnaces now in use, and we understand will be used for the eight open-hearth basic furnaces now under construction. It is reported that at the Edgar Thomson works no great success was obtained.

In the above named works, of course, the process is used in connection with the production of ordinary structural steel. The application of the process to the production of crucible steel is less advanced; but here seems likely to lie by far its greatest importance. As good evidence of the success of the process in this direction, Mr. THIELEN showed samples of tools, sheep shears, scythes, case knives, planer knives and many other articles made from steel carburized by this process and samples of round and octagonal machinery steel, whose fracture indicated a material equal at least to fair crucible steel. The manufacture of crucible steel is a slow process, requiring much hand labor, and the finished steel costs from 5 cts. per lb. upward. There seems every reason to believe that basic steel can be made and carburized by the process described by Mr. THIELEN, at a cost of less than 1¼ cts. per lb. It would be too much to expect, of course, that this material will equal the best grades of crucible steel at the start; but even if it approximates to crucible steel in quality and can be bought for 1¼ cts. per lb., it practically places a new and most valuable material at the disposal of the constructing engineer.

It is to be borne in mind that the process is not an expensive one. In fact, it costs much less than the ordinary process of carburizing with spiegeleisen. Thorough practical tests at the hands of most experienced metallurgists have proven its success. Mechanical engineers can therefore fairly expect to be able in no long time to be able to purchase a metal nearly or quite as good as crucible steel for from 1½ cts. to 2 cts. per lb., and the advance which this may render possible in machine design may be far reaching.

The samples of tool steel exhibited by Mr. THIELEN, carburized by the Darby process, have been presented to the museum of the Engineer's Society of Western Pennsylvania, where they can be examined by any one interested.

As for the effect of this invention on the Bessemer steel output, it seems likely to give the basic steel considerably the advantage over the older product. Heretofore basic steel has been so low in carbon as to be best suited for use where very mild steel was specified; but by the Darby process any degree of hardness can be given basic steel, and its smaller percentage of phosphorus will give it the preference over its older rival. Again, for many uses to which steel is put a metal of higher tensile strength containing more carbon might well be used were it not for the considerable percentage of phosphorus. With this eliminated, it may be that we shall be able to increase by 10,000 lbs. or so the allowable tensile strength of structural steel, and the great importance of this gain, if it can safely be made, need not be dwelt upon.

Enough has been said to show that the invention is one which is of great importance to all branches of the engineering profession, and it is greatly to be hoped that its full success may be achieved.

The Colorado Canon Survey.

It rarely happens to any journal that it can present to its readers a series of views of a region heretofore practically unknown to man, as the Colorado Cañon was, and one wholly unknown heretofore in an exact and technical sense. Such a series we give in this issue, engraved from selected photographs taken by Mr. ROBERT B. STANTON, Chief Engineer of the Denver, Colorado Cañon & Pacific Ry., in his late remarkable and almost unprecedented trip through the awful gorge of the Colorado. Mr. STANTON is the first person who has ever been able to take photographs of much of the Cañon. One man only has preceded him in the trip, Major J. W. POWELL, now at the head of the Geological Survey, who made an exploratory trip in 1869, and whose description of the appalling immensity and grandeur of the cañon has been one of the most serious obstacles in the way of regarding it as a practicable railway route. Major POWELL, in fact, freely and publicly expressed the opinion, about a year ago, that such a project was utterly chimerical and impracticable. Nothing less than a complete exploratory survey of the cañon made by a competent civil engineer could demonstrate the contrary. Such a survey Mr. STANTON has made, with results set forth in this issue, through dangers manifold but with complete success, and that he has demonstrated the route to be entirely practicable will be the general judgment of engineers, whether or not they think the time has come for constructing the lines.

To say this is not to impeach the general accuracy of Major POWELL'S description of the cañon *as he saw it*. He saw it only in its *ensemble*, with the eye of an explorer and a geologist. He did not and could not see it with the eye of an engineer, for he is not one; and hence could not confine his thoughts to the narrow belt just above high water line, which is all that concerns the engineer, and which will be seen to be in most of our views of an anything but impracticable nature, albeit our views are for a quite disproportionate number of the rougher spots, long stretches of the easier work being hardly represented at all. To comprehend this more clearly reference should be had to the table which appears in this issue, showing in miles the actual amount of each kind of work in the whole route. Roughly summarizing this, it will be seen that of the 490 miles of cañon proper no less than 78.4 per cent. is comparatively easy work, and only 21.6 per cent. "high cliff work," "sloping and heavy granite walls," etc., for the last seven classes of work in the table.

For reasons given more fully in our issue of Sept. 21, 1889, when we published the first series of these views, covering the upper part of this great cañon, we hold it to be quite impossible for any one not an engineer to form even a valuable impression of the practicability of a cañon route like this for a railway. To the really skilled and

experienced engineer such a route as we picture appears neither less nor more difficult than if the entire top of the gorge down to a level 50 to 100 ft. above the water were sheared away. The "top hamper" does not matter in the least, except in the one respect of danger from possible slides or rock falls, which Mr. STANTON declares to be small. But to the eye of the mere explorer or impressible amateur, how vast a difference would such a shearing off make, especially in his recollections after 30 years!

It is to be remembered that every one of the views which we engrave are on a vast scale. The highest points shown in the distance are rarely less than 2,000 to 3,000 ft. high, and often more. The width of the river is rarely less than 200 to 300 ft. We regret that there are so few objects in the views to give a scale to the eye, so that the real scale could be appreciated; but in re-productions of photographs taken under such circumstances this lack is unavoidable. By mentally shearing off all the upper part of the view down to within 100 feet of the water, the eye of the engineer, even, will be greatly aided in appreciating what the real difficulties of construction are, which are certainly not greater than have been coped with on many of the Colorado and other far Western lines with very moderate average cost per mile.

It might have been predicted with certainty that the cañon in its entirety, and as an average, could not be so very forbidding for a railway line, from the known characteristics of cañons, resulting from their process of formation, as discussed at some length in our issue of Sept. 21, 1889. The larger the cañon the less likely that much sharp curvature will be needed, or that a large proportion of the line will be cliff work. Every cañon, from the nature of its formation, is a succession of pools and gorges. In the gorges much rock work is necessarily required, but it is done under favorable circumstances for doing it cheaply, especially in this era of power drills and high explosives. It is blown off in great masses; it furnishes just the material required for an immovable road-bed; there is next to no hauling necessary; rough retaining walls are readily and cheaply constructed (as hundreds of miles have been in Colorado and elsewhere); little masonry is required, and there is no trouble with foundations or cutting of water.

In the more open parts of the cañon, where there are talus slopes, there is still less trouble with construction, because there is less rock to blast, while there is enough rock and rocky material in the slopes to make the construction of a permanent road-bed lying chiefly in excavation easy. All this has been illustrated many times over on the Colorado lines, where some of the most brilliant engineering, in the truer sense, ever done is to be seen; that, namely, of accomplishing great results at the smallest cost, by strict subordination of means to ends.

On the great question—Will the line pay?—we cannot undertake to express any opinion further than this: it certainly affords the lowest grade line between Colorado and the Pacific, and a line not much longer than others, even to San Francisco, and so should be able to successfully compete for freight, especially coal and minerals; while it would still more certainly afford the grandest of all passenger routes in this country or the world, and so should draw to itself a very heavy passenger traffic. Mr. STANTON also claims that a considerable local traffic is already "in sight." We know how marvelously such railways will sometimes create it in this country.

That the line would be likely to prove especially attractive to passenger traffic would be still more clearly seen from our engravings could they have been made in colors. For this cañon is no ordinary one, with dull grays and browns for tints. every part of it is most brilliantly colored after the fashion of the Yellowstone Cañon, which has now become pretty well known. The water is deep, and dark in color; the vegetation, what little there is of it, is in small intensely green patches; the rocks are vivid and decided reds, yellows and blacks, all these tints existing together almost everywhere, and being varied and shaded into each other, as an effect of weathering, in a way quite impossible to describe in words, and which can only be appreciated by those who have had the good fortune to see a series of colored photographs, such as were exhibited at the Cresson convention of the Am. Soc. C. E., with the assurance that even these do not fully reproduce the glory of the coloring. If so, this line, if built, will be one which no tourist will neglect if he can possibly arrange to go over it, and that means a large passenger traffic with little need for cutting of rates to secure it.

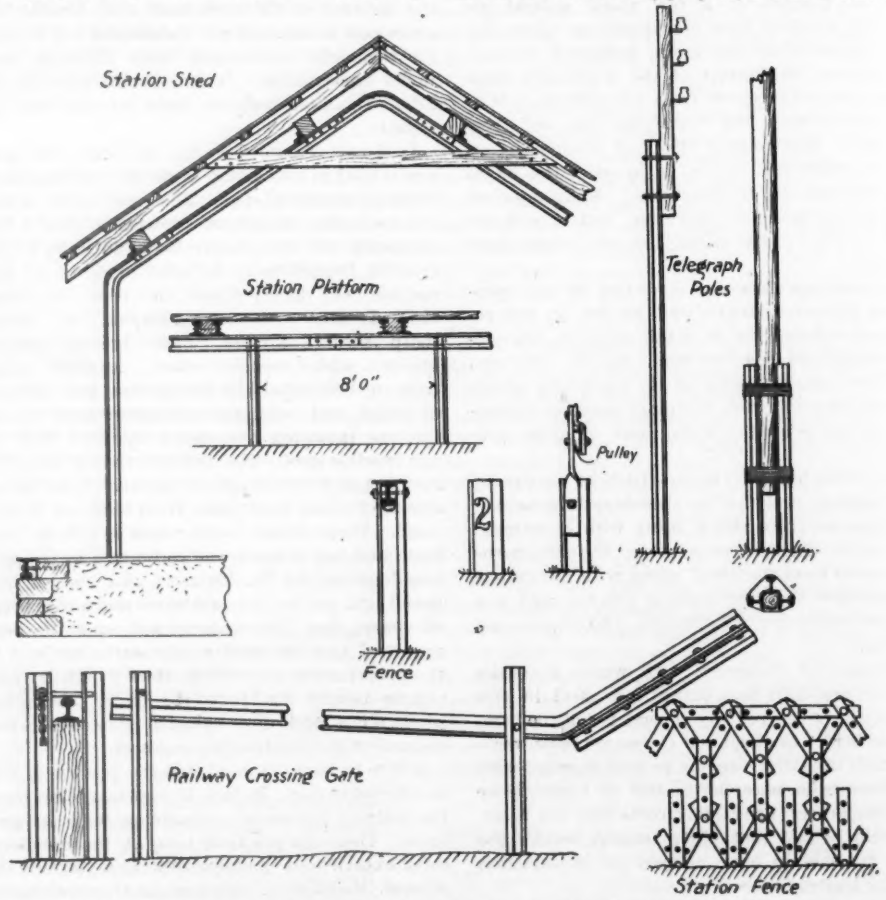
In any case, we are enabled by Mr. STANTON'S kindness to present to our readers herewith the record of one of the boldest and most hazardous exploratory surveys ever made, and a long series of views on which the eye of man has rarely or never rested before, a half dozen bold explorers alone excepted. As such, they will both have deep interest.

Diagonally Through Russia.

[EDITORIAL CORRESPONDENCE.]

[*Continued from page 324.*]

Russian railways are well constructed and well cared for, the stations are substantially built, and the station restaurants are good—for Russian appetite and digestion. But, nevertheless, a railway journey of 1,500 miles diagonally across the great Empire of Russia has its tribulations, and the American traveler misses sadly the many comforts—now necessities—that tend in his own country to lessen the fatigue of such a journey.



RUSSIAN METHODS OF UTILIZING OLD TRACK-MATERIAL.

In the first place, until we reached Moscow, 1,100 miles from our starting point, there were no sleeping cars, the only substitute being a vehicle with three of the ordinary European compartments, opening on a side passage running the length of the car, and a rear compartment provided with six upholstered chairs that could be let down and used as a couch. In the smaller compartments the backs of the facing seats could be raised to a horizontal position, and a fixed step under the car window provided access to the upper berths. But no bed-clothes or pillows are provided for either these or the folding chairs. The smaller compartments have only one central window that is ingeniously arranged so as to compel the traveler to elect between the chances of a cold in the head and of remaining hermetically sealed up for the night, for the guard carefully keeps the door shut that should open into the passageway, and of other ventilators there are none. The compartments, first-class, are intended for six persons, as a brass plate over each seat distinctly sets forth; but just how six persons could dispose of themselves on four very narrow shelves over night was a problem that we were fortunately not called upon to solve.

Each first-class carriage is provided with a water-closet and a so-called "lavatory." But as the closet was usually very dirty, and the "lavatory" was also very dirty and provided with a tank holding about two gallons of water when full, these "luxuries" were rather matters of fiction than fact. The washing conveniences were especially delusive, as from their design and the fact that all the cars on the line we traveled over were entered from the ends, the first-class cars were easily accessible to the second-class passengers; in fact, the same car was often divided between the two classes. As a result of this arrangement, and the general paucity of the water supply, the first-class traveler had to get up early to obtain his share of the two gallons of water.

The peasant of South Russia is rather careful in the use of water for any purpose, and as a rule he wears his clothes until they wear out. As a consequence of this eccentricity of the people the cars that carry the lower class carry also a considerable "dead load" that is very much alive, and the vermin at times escape from their habitat proper and are in evidence in the first-class carriages. Fleas don't count in this category, as they are everywhere, as a matter of course; the vermin referred to were of a much more savage breed.

As none of our party spoke Russian we were

hardly competent to judge of the average Russian railway employé. The guards and ticket collectors presented the usual assortment of characteristics; some were brusque and even uncivil, but the majority seemed to be inclined to help us, and we found that a rouble (about 60 cts.) was as potent among them as francs and marks in Central Europe. The objection to them as a class was that they did not keep things as clean as we should have expected in a country where public affairs are conducted on strict military principles. As an example, the chintz covers of the reclining chairs were very dirty and an all-pervading composite odor of caviar and cheese made too close contact with them anything but provocative of balmy sleep.

The station restaurants, as noted, were unexpectedly good; they are conducted by the Government, and are seemingly under strict regulations. The buildings themselves are well constructed and well arranged for their purpose, and at the regular stopping places for meals the supply of food was abundant and as good as could be expected in that country, and the prices were reasonable. But the stop allowed for meals was short, very short for the American who could only "point at" or "grab" his food for lack of a Russian vocabulary to ask for it. In this emergency our party will ever have in grateful remembrance the Russian cabbage-soup that was to be found in every railway restaurant; we lived upon it practically from Batoum to Moscow. This soup had in it plenty of cabbage and other vegetables, and each plateful was garnished with a generous chunk of boiled beef. It was, in fact, soup, vegetables and meat in one helping and one payment, an arrangement of most decided advantage to our hungry party, and a compound that was in itself very "filling" for the money invested.

Drinking water is not provided on the trains, and as the wise traveler in these countries is careful in the matter of quenching his thirst with the water that he finds at the stations, we resorted to the Russian national dish of tea. The samovar was bubbling everywhere, but as a rule we found Russian tea to be a very weak beverage, from an English or American standpoint.

To break our journey, after about a day and a night and part of another day's excursion from Vladikavkas, we stopped off at Novocherkas, the capital city of the Don Cossacks. We had learned from a fellow traveler the name of the best hotel and with the assistance of two little droskies and two positively filthy drosky drivers we got to the hotel, only to find that English, French and German were of no avail in treating with the landlord and his assembled henchmen. Russian alone was understood. Our train had departed and the hotel looked reasonably clean, so we made up our minds that we would stay all night in spite of our landlord's linguistic deficiencies—to say nothing of our own. By shrugs, grimaces, nods of approval and various other bodily and facial contortions we obtained suitable rooms and got rid of some of the dust of travel. But to order dinner was an important and more serious matter. We were politely handed a bill-of-fare (—) in Russian script, and for 15 minutes we fought it out with the head-waiter, with no other result than to have him call for reinforcements in the shape of the landlord, four other waiters and the cook. We were hungry and wanted something to eat; they, with anxious faces and heads thrust forward, showed every disposition to serve us; but our combined efforts were in vain until one of our party suddenly remembered that in the back of our "Murray" there was a thin vocabulary. It was a blessed discovery, and we at once proceeded to order "bifstek" and other things to eat and drink in an American-Russ dialect that finally conveyed a meaning to our eager attendants, and it was hard to say which were the most gratified at the happy termination of our troubles. In the evening the head waiter triumphantly ushered a German-speaking citizen of the town into our presence, who had kindly consented to act as interpreter, and from that time forward until we left the next morning our path was comparatively smooth.

The country traversed in reaching Moscow can be described in brief terms, for there was much sameness about it. Back of Vladikavkas, toward the main chain of the Caucasus, the black mouth of the Dariel gorge, was just visible, and over all the snow-capped peaks of Mount Kazbec glittered in the sunshine. But the railway rapidly diverges towards the northwest and the mountain chain is soon lost to view, Mount Elbruz alone piercing the clouds and appearing and disappearing behind them with its 16,000 ft. of elevation. Then come the steppes of South Russia, vast rolling plains covered with yellow grass and sparcely dotted here and there with timber along some winding water course. As Rostov is approached, near the head of the Sea of Azof, the lands show cultivation and we realize that we are on the borders of the granary of Russia, the rival to our own wheat-growing territory of the Northwest. The Russian villages that appear along the line are straggling collections of thatched farm houses and barns, each farm yard abutting against its neighbor and usually extending along the two sides of a small river and literally stretching out for miles in some cases. These same steppes, with forests of greater or less extent, reach on to Moscow itself, the villages growing more frequent and at times changing into towns and cities of very considerable extent and of European types in the better dwellings and public buildings.

The people are picturesque if they are dirty; at the stations nearer the Caucasus, in Daghastan, the most common dress is the long coat with cartridge tubes on the breast, the waist belt loaded with dagger, modern revolver and the Circassian sword, and the head covered with a lamb's wool cap. In the morning or evening all other dress is often hidden under the long sheepskin cloak, or *bourka*, and the head covering takes the form of a huge sheepskin hat of the mushroom type. As we pass Rostov and enter Russia proper, or rather the country of the Don Cossacks, the dress changes and the arms disappear, except with the military themselves. The peasant now appears in the ugly, high Russian cap and the invariable red shirt worn outside of the baggy breeches stuffed into high boots. The women wear boots too, and their dresses reach to the tops of their boots. As a class the people seemed to be industrious and prosperous, and except in their broad, stolid features and a certain look of resignation to their lot and great respect for those in authority over them, there is little left to remind the traveler of the state of serfdom from which they have so recently passed.

Returning to the railway and some of its distinctive features, the roadbed was in excellent condition; the track is laid to a 5-ft. gauge on timber cross ties, with splice-plates much after the American fashion. The road is well ballasted with broken stone or gravel, with the edges of the ballast as carefully trimmed and lined as on the best of English or American roads. The ditches are well kept, and all grade crossings are guarded by gates. The little masonry seen was of an excellent character.

The one thing that especially attracts the attention of the engineer, however, is the many ways of utilizing worn-out rails and track material. Rail mills are so remote from this country that it does not pay to carry this material to them for reworking, and as a consequence the Russian engineer has taxed his ingenuity in finding ways of disposing of the old iron along the line, as shown in part in the accompanying sketches. A length of rail planted in the ground, with a short piece of wood fastened at the top with two stirrup irons, makes a serviceable telegraph pole. In other cases three and sometimes four shorter pieces of rail, extending about 5 ft. above the ground, form a base for a longer telegraph pole of wood, which is thus protected from decay. In the latter case old telegraph wire is the chief fastening used. The frames of freight sheds are made of old rails, bent at the eaves and the peak of the roof and the sections connected by the regular splice-plate. Rails form the beams and posts for freight and passenger platforms, and often cap the stone walls of these platforms. Sections of rail planted in the ground are used as section and signal posts, and carry the pulleys of the signal wires. Old rails make the fences at grade crossings and the counterbalanced gates at these crossings as well. The oddest use of all was the very decorative fences around many of the stations, formed solely of discarded fish-plates and old track bolts.

Each wooden telegraph pole along the line is numbered and dated with the year of planting, a wise provision that could be followed with great advantage in other countries, as it would be especially useful in collecting statistics bearing upon the useful life of such timber under varying conditions of climate. This is not only so with telegraph poles. Every wooden post marking the line of the great military road across the Caucasus is also thus distinctly marked, and it was interesting to note the stages of decay as we went along and compared them with the dates. The posts of 1885 were already much split and decayed at the base in many cases, and were being replaced.

As to railway masonry, that seen upon the tunnel line, almost completed, for avoiding the steep grades of the Suram Pass on the Batoum-Baku railway, was wonderfully fine. The piers of great viaducts, 60 to 80 ft. high, were as finely finished and as ornate in design as if they were located in a great center of civilization, instead of in the wild gorges of the Lesser Caucasus. Retaining walls, 80 ft. high, were built of squared stone, and in the center of their height the date—1889—was worked out in projecting blocks in figures 12 to 15 ft. high. The entrance to the new tunnel was a highly ornamental piece of masonry, and on every hand there was an air of artistic finish that could be only accounted for by an abundance of most excellent and easily worked building material near at hand, and a conscientious determination to make "a good job" of it.

The railway from Moscow to St. Petersburg runs also through a generally flat or gently undulating country very sparsely settled, and more or less wooded. The famed "straight-edge" location of this line by the Emperor, NICHOLAS I., is practically the shortest and best location that could have been made. The fact that it left to one side or the other some important towns was of little moment to a master who was considering the location from a military rather than a commercial standpoint, and as branches now connect these towns with the main line no harm is done them—from a Russian standpoint.

The rolling stock on this road is better and cleaner than on the Southern lines. The cars open on the ends and are very similar in general design to those described. But the chair cars are carpeted, cleanly upholstered and well lighted, and the sleeping compartments, while made up as before described, are provided with a complete outfit of bed clothing. The Pintsch light is used in the first-class compartments, but proper ventilation is the one thing generally neglected on the Russian railways. A double sash of glass at the car windows, with one sash screwed down for the summer, indicates that winter travel is severe, and the then condition of affairs may account in part for the non-use of ventilating openings. Near St. Petersburg, the thermometer, in December and January, sinks as low as 30° F. below zero, and even lower at exceptional times, so we cannot judge of the construction of Russian railway rolling stock by American standards. In passing through the steppe country, bordering the River Don, we found the country dry and parched, and the prevailing violent wind was so ladened with dust as to literally preclude any distant view, and it hid from us the city of Rostov until we were within its limits. These clouds of wind-driven dust followed us over a great part of the flat country lying between Rostov and Moscow, and it was easy to imagine that when snow had replaced the dust a tightly closed car was somewhat of a necessity.

In connection with Russian sleeping cars and Russian railway management, it might be remarked that several days before leaving St. Petersburg we took the precaution to send a porter to secure for us sleeping accommodations for a certain night train to Berlin. We were informed that every berth had already been taken, and as our arrangments were made for departure we had to content ourselves with a first-class compartment in the day coach, which would only allow two persons to stretch out at one time. After we had started, we found that the whole sleeping car, for there was only one in the train, had been taken by the Grand Duke GEORGE, the nephew of the Emperor, and about four or five attendants. As Americans, we had no objections to traveling in company with the Duke, especially as his chances of succession to the crown were so remote as to relieve our minds on the score of the possibilities of Nihilistic dynamite; but we did think that in other countries than Russia the railway management would have provided a special car for his Highness, and left the general traveling public in undisturbed possession of the regular train coaches.

In Prussia and beyond to Holland we found the railway carriages to again take the usual European compartment form with doors in the sides. But the seats were somewhat of a novelty and were so arranged that the opposite seats proper could be pulled out to meet, and the cushioned back on one side came down so as to form an inclined head rest. To the traveler, provided with a rug, this arrangement makes a very good bed for night travel. But as our conductor insisted upon seeing our tickets several times during the night and left the door open while doing so, our rest was decidedly broken and the chill night air was not conducive to comfort.

It is hardly necessary to state in conclusion that the hasty notes here gathered together are the results of a flying trip made purely for purposes of pleasure and not for professional gain. To write up in any really valuable manner the interesting engineering features of the countries passed through meant more deliberate and continuous work than we could give it in the allotted time, and a wider acquaintance with foreign tongues than was our fortune. As an example of the provoking side of this inability to ask questions and the difficulty of finding men to answer when asked through an interpreter, we might mention a case in Anatolia, in Asia Minor. In a 24-mile drive from Modania, on the Sea of Marmora, to Broussa, at the foot of Mt. Olympus in Asia, we noticed an apparently well built narrow gauge railway, with excellent brick masonry along the line and the rails laid clear to Broussa. As near as we could find out the track had been laid 17 years ago by an English company, but an engine had never passed over it and the project was abandoned. There was evidently a considerable investment of capital and Broussa was a large town with a very considerable silk industry, and we were very anxious to know why the scheme had been so abruptly dropped. All that was learned by persistent questioning through our dragoman was, that road was "too zigadyzag" and that the engine shipped, and still rusting at Modania, would not fit the track as laid. We could not see the location over the mountain ridge lying between the coast and Broussa; but from what we did see and hear concluded that the location was so bad and the curves so sharp that the engines provided could neither haul a load nor keep the track. But we should have been better pleased to know more, could the information have been obtained on the spot.

CORRESPONDENCE.

Engineering Notes from the Far West.

Los Angeles, Cal., Sept. 30, 1890.

To the Editor of Engineering News:

Sir: Notes from the far West are so comparatively infrequent in your columns that a few taken by me on a late trip from St. L uis to California may be of interest.

Going out of St. Louis via the Chicago & Alton, crossing over the old Ead's bridge into Illinois, from one point of view can be seen both the old and also the new bridge. The contrast is notable. The arch bridge, at the time it was built, a bold feat of engineering, both as to long spans and deep foundations, is now a kind of monumental relic; while the Merchants' Bridge, of equal practical value but far less cost, is a type that is rapidly becoming an every-day occurrence to build. But in the midst of the rapid strides in bridge building, the nerve and genius displayed in the construction of the old must not be forgotten, nor will it ever cease to be appreciated; for the lines of the arches are so much more pleasing than those of the trusses above, that it will call for increased admiration of the great work of Ead's life.

The roadbed of the Chicago & Alton R. R. is in good condition, but the regular click as the wheels run over the opposite joints in the rails speaks somewhat of hammered ends. The crossing over the Illinois River is by an old bridge, part of which is Post truss, with four trusses to a span, two side by side on each side of the track, an arrangement which is not conducive to equal loading, unless some special beam hanger was used, and this could not be determined as we ran across.

The Mississippi River bridge was long, and made up of many short spans, with a draw; but almost every detail on the bridge is of antiquated design, good at the time, but now rapidly falling into disuse, in the face of such excellent work as the Merchants' Bridge or the Huntington Bridge at Cincinnati.

The name plate announces the Missouri River to be spanned by a "steel bridge," built when steel was only beginning to be used, and designed by W. Sooy Smith. It presents a solid appearance, and it was a question why the train should be limited to 8 miles an hour in crossing. The intermediate posts approximated in form the Strobel column, being formed of four bulb angles, the bulbs turned in opposite direction to those on Carnegie's bulb angles. Then the top lateral struts were of four angles, placed at the corners of a square and laced on all four sides—a form which is not often seen on truss work of this type.

From Kansas City on the "Rock Island Route," or Chicago, Kansas & Nebraska Ry., through a parched and barren country, where there was little of interest to an engineer; all that could be seen was knee high corn, "done brown." The roadbed through western Kansas was remarkably smooth for two years' service on mud ballast and under difficulty.

There is much at Denver to interest one, but the Colorado Cañon survey and the hero of it, Chief Engineer Stanton, are prominent subjects of conversation among engineers.

Irrigation surveys are in progress in different places, and it is likely there will soon be built some dams to rival and eclipse those of California.

The new capitol is the largest contract under way about the city; it will be a huge granite pile when complete, and an ornament to the city, crowning, as it does, Capitol Hill. The iron work is being furnished by P. E. Lane, of Chicago, *i. e.*, by the Lane Bridge & Iron Works, and a large amount of the beams and some box girders are already on the ground or in place. This company also have a number of good highway bridges about the city, being the only firm having a representative in the place. There are several foundries which make architectural castings, notably the Colorado Iron Works and the Denver Architectural Iron Works, but none which engage extensively in wrought iron construction.

The boiler works buy nearly all plate iron in Pittsburg, and after freights are paid it begins to have a golden hue. Cast iron is mainly procured from Pueblo, but Southern iron is finding its way to this market.

At the Colorado Iron Works nearly all the work in the shops was machinery, much of it for the mining regions. The rise in silver has infused a new energy in all of Denver, but only a few columns for buildings were to be seen, and one of these was being operated upon by a curiosity of a machine in the shape of a rotary planer having only one cutter

One of the first things to strike the eye on entering the city is the unpaved condition of the roadways of the streets; but the contract has been let for paving nearly all the business portion, and a half block of asphalt was being put in on Larrimore street, near the City Hall, for a trial. There is the usual fight between stone-block and asphalt representatives.

Here can be found any kind of stone, of any degree of hardness or durability, of any shade or color, and there are more residences of stone than in almost any city of the size in the United States, some of them having combinations of color giving beautiful architectural effects. One stone particularly to be admired is a whitish lava rock of close grain and quite hard; but upon close examination it is found to be full of flaws or blowholes. A lofty business block was pointed out which had been built of it, and when nearing completion was found to be cracking near the base, and was condemned and pulled down! This will probably limit the use of lava rock to smaller structures.

Particularly to be admired are the cable and electric railways which reach every part of the city. They are all built narrow gauge, and run at good speed. The Denver Tramway Company own the greater part of them, including the Lawrence Street Electric, which is run on the Thomson-Houston system. The road is over five miles in length, through a busy part of the city, and has proven such a decided success that the company intend putting in other lines at once, and will ultimately replace the cables with electricity—so I was informed. The power plant consists of eight 500-volt dynamos, which are running 22 hours out of 24, and giving no trouble, but behaving elegantly, according to records.

Denver certainly has business prospects unexcelled by any city on the continent, and, as mentioned before, the Silver Bill has quickened all branches of business, and the air is full of rumors of new railways in all parts of the State.

Leaving here by the Denver & Rio Grande, I found narrow gauge trains still running, but the third rail is laid part of the way through the mountains, and it is expected that standard gauge trains will be running within a month or so. On the Rio Grande Western, from Grand Junction to Ogden, the change had been made, and trains which would be an honor to the Pennsylvania R. R., in point of elegance, were running. Numbers of new bridges, of elegant design, built by the Detroit Bridge Co., were seen, which had been erected during the year, and several plate girders were on the ground not yet erected.

At Ogden, Utah, the first glimpse was caught of true "Western" travel in the cheap equipment on the Central Pacific, or rather old equipment, as one would imagine they were trying to wear out their old cars.

When the snow sheds of the Sierras were reached they were found undergoing extensive repairs. One would guess, at least, half of them to be rebuilding, and great piles of lumber, 3 ins. for cover and 1½ ins. for sides, were distributed along the line. The experience of last winter has rendered this work a necessity.

Passing the great Placer mining region, the hydraulic apparatus is seen lying idle and going to waste; hundreds of acres which were washed bare by the miners have now a scrubby growth of pines and will in a few years be entirely hidden. Way down in the valleys can be seen the sand and gravel washed there by the hydraulics, covering up whole farms. This was the cause of the restrictive legislation which put a stop to it.

On this road are a class of laborers not seen in the East, and which are somewhat of a curiosity. The "noble red man" was seen shoveling coal at a relay station, and the entire line is kept up by Chinese section hands—at least so far as could be seen—and they displayed about as little energy as possible. One was seen carrying a pile of rubbish the entire length of a passenger car by shovelsful to a wheelbarrow, which could as easily have been run to the heap; and this is only one example.

On the line from Sacramento to Los Angeles, in the mountains, near Tehachapi, there is a loop in the location which is seldom heard of, as it is eclipsed by the famous Georgetown loop on the Rio Grande; but still it is worth seeing. As the road climbs up the mountain it passes through a tunnel, then makes a complete circle of a conical peak, and finally reaches a point directly above the tunnel, from which can be seen the entire loop, spread out like a map. As we pass out of the mountains the roadbed is entirely new, being located much higher than the old, which was washed out by the floods of last year, and only patches of it can be seen here and there, the abutments of a bridge or an old trestle work.

The newer iron bridges were all built by the Phœnix Co. The work on the roadbed was still in progress, and gangs of coolies were camped in cars on the sidings at different points along the line.

Much censure of the company can be heard on all sides, both from employés and citizens, on account of their discharging white labor, which was receiving fair remuneration—perhaps exorbitant in many cases—to employ Chinese labor at 90 cts. per day.

From all that can be learned, no trouble is experienced in importing Chinamen, notwithstanding the restrictions upon it. Indeed, one soon becomes accustomed to seeing them everywhere. Great gangs of coolies in their picturesque bamboo hats, cultivating the fields, driving the market wagons, doing servile work about residences, and above all working in the Chinese laundry, which is everywhere present.

The depot of the Southern Pacific here in Los Angeles is a frame structure, like most buildings in the city, quite commodious and elegant, and being tastefully painted and having the usual accompaniment of lawn, palm trees, bananas and tropical plants, it excels most Eastern stations in beauty. Their seaport is at San Pedro, 22 miles from here, which is now the point of departure for vessels to Santa Barbara, San Diego, Catalina Island and San Francisco.

But Redondo, only recently of any importance, the port of the Santa Fe system, bids fair to outstrip it in freight business, and has become quite a resort as well, being the seat of a Western Chautauqua. At the time of my visit one branch of the pier, which was V-shaped, was being torn away, while the other was being doubled in width and extended. Among the piling, which was being tarred and covered for driving, was an Oregon pine stick 112 ft. long, as smooth and straight as a lead pencil! The foreman stated that the present pier was only temporary, as the company expected soon to build a steel pier; this was only expectation, however.

Near Long Beach, some time since, was seen an engineer's camp, and upon inquiry it proved to be the locating survey of the Los Angeles Terminal Co. Calling at the general offices on Second St., we found W. F. McClure, M. Am. Soc. C. E., to be Chief Engineer, and a very pleasant and affable gentleman. The location is nearly all done, and construction of the line to the ocean at San Pedro will commence with the first of the year. The stations, of which some plans were seen, will be very tasteful affairs. No bridges will be built on this part of the line, as trestle work will answer in all cases.

There are in this place several firms engaged in iron work, the principal firm being the Baker Iron Works, who do mostly engine work, but also architectural castings.

They use pig iron from Oregon, some Southern iron, but mostly English iron as well as coke, which are brought in as ship ballast. Shape irons are bought from the Pacific Rolling Mill Co., at San Francisco, who now roll beams up to 10 ins. and turn out very smooth sections.

Most of the bridges in the country about are cheap combination affairs or wire suspension bridges. Some of the former are solid and durable, but the latter is of a kind, for which there is no excuse or defense.

Built by guess, of single wires laid into a cable or cables, with no means of insuring even tension, anchored to gas pipe or timber, which is often insufficient, having gas-pipe towers with no sway bracing between, wire suspenders, tightened by "twisters." The floor is laid across on "floor cables," which cannot take a bending stress, and in no way are a defensible construction. It is no wonder that we hear of them falling, as did one at San Bernardine a few weeks ago, although it is claimed that it was the masonry which gave way, that having been probably guessed at as well.

About the city are some fine structures carrying the cable roads over the river, and carrying the elevated track on the Downey Ave. line over the railways. The last was built by A. Gottlieb, of Chicago, and is of elegant design and workmanship.

Calling on City Engineer Eaton, M. Am. Soc. C. E., we found his force to be reasonably busy doing city work—sewers, pavements, curbs, street lines, and the usual class of work. The quarters in the city building are elegant in their appointments, a large private office, sumptuously furnished, opening off the draughting room, where several draughtsmen were busy on plats and plans. Quite a number of surveyors and a few engineers have offices in the city, and keep the amount of work—which is not great since the boom—well in hand.

Outside of surveying there is very little work of an engineering nature to be done in this immediate vicinity, so far as can be learned.

C. E. Fowler,

The Denver, Colorado, Canon & Pacific Railway Project.

[CONTINUED FROM PAGE 344.]

mountains have dropped into the bowels of the earth and toppled over as they fell. The whole country looks but the sad and awful reminder of its former greatness. (See Photographs Nos. 643 and 659.)

It is certainly a misnomer to call this section of thirty-five or forty miles a "canon." It is a valley, broad, and in many places flat, with sloping hills and hillocks. About 18 miles above Diamond Creek this broken and rended country ends, the granite comes up once more, and the noble marble cliffs stand up in their greatness and boldness as before. The granite only occurs in patches, and between these the valley is wider and wider than above.

From a point about two miles above Diamond Creek for some thirty-six miles (in round numbers) below, the river runs through a second granite gorge almost of the same form and proportions as the great granite gorge at the head of the Grand Canon. The granite is mostly gray and black. It rises higher than that in the gorge above, and in general it slopes up from the water at angles varying from ten to fifty degrees from vertical. It has not, however, the regular slope of the upper gorge. In its first half, the buttresses are massive rock that jut out over the slopes and

IN THE GRANITE GORGE BELOW BRIGHT ANGEL. (Photo 441.)

IN THE GRANITE GORGE BELOW BRIGHT ANGEL. (Photo 469.)

into the river, are bolder and more numerous, the granite is more compact and solid, and is cut through by more side canons and washes. In fact, this section from Diamond Creek to the end of the gorge is the grandest, most bold and most difficult part of the whole canon as seen from its lower depths.

And here we found the much talked of and long looked for *perpendicular granite cliffs*. They do exist. And they stand in their mighty grandeur and frown down in their ugly blackness upon any attempt to peaceably navigate this wonderful river over which they stand guard, and to the *unpractised* eye seemingly forbid any attempt to construct a railroad through its narrow confines. But when brought under the cold calculation of the transit and chain, the problem is reduced to this: In this whole section of some thirty-five miles there are not over 2,500 feet of perpendicular granite cliffs that would, in any way, affect the building of a railroad line. The lower half of this granite section has flatter slopes, the rock is much more broken up and seems to be formed in horizontal strata that for long stretches form easy and partly level benches. (See Photographs Nos. 673 and 732.)

From the end of the granite to the Grand Wash Cliffs, the canon is but a repetition of the lower end of Marble Canon. The granite and sandstone have sunk below the river, and the limestone and marble cliffs come in close to the water. At their base, great slopes of the softer limestone and piles of broken rock forming a continuous talus, stretch down to the water's edge. The inner gorge, which now runs to the very top of the canon, is much broader and more open. (See Photograph No. 737.)

Putting this general description into a condensed table we have:

TABLE OF CLASSIFICATION—GRAND CANON.

Distance in Miles.	General Character of Work.	Photographs Illustrating each Class of Work.
51.050	Hillside slopes, E. & L. R. & S. R.	The Photographs illustrating Grand Canon, are given by sections in the text.
43.750	Heavy talus slopes, L. & S. R.	
11.600	Cliff bench-work—sandstone	
3.000	High cliff and bluffs "	
1.250	Solid rock slopes "	
.200	Heavy embank., in river	
19.000	Marble bench work	
85.925	Sloping granite walls	
.875	Tunnels—(6 tunnels)	
.500	Vertical cliff and *half tunnel*	
217.150	Total.	

This brings our line through all of the great canons and into the open country below.

At the Grand Wash Cliffs the whole country drops, or rather the whole country has been washed away, and the canon ends in an open, hilly country with gentle, easy slopes not unlike in general many of our Eastern river valleys, with, however, mountains rising up back from the river. (See Photograph No. 756.)

While the general character of the country below the Grand Wash is that of an open valley, in places the granite rises up on either side of the river and forms a number of "canons"—notably the Hualapai, Boulder, Black and Mojave. Generally the walls of these canons are low and flat and the rock much broken up, and easier to handle than the walls of the great canons above. But in two points, a couple of miles each at the head of the

THE GRAND CANON BELOW THE GRANITE AND ABOVE KANAB. (Photo. 598.)

Boulder and Black Canons, there is some difficult and expensive work. The walls stand vertically from the water's edge, and the question of a railroad is effected by the fact that this portion of the river from its mouth to the Rio Virgin, *is a navigable stream*, and that steamboats, 180 feet in length and carrying 80 to 100 tons of freight, pass through these narrow canons.

The only question here is the matter of expense in construction of several tunnels in order not to obstruct the river. Very much the greater portion of the line from the Grand Wash to the Gulf is over open flat lands—and low bluffs and slopes of gravel wash—many miles through the Colorado, Mojave and Chemhuevis Valleys, being perfectly level bottom lands of earth.

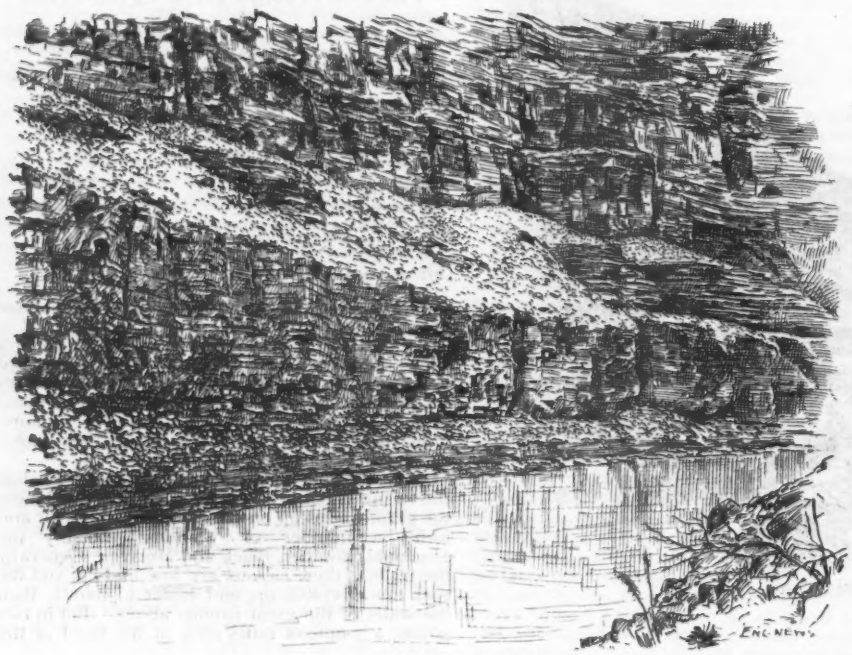
It is not necessary to give a more detailed account of this lower country. The results of the whole survey are given in the table on page 357.

Look for a moment at the items of this table with reference to cost of construction.

In a distance of 1,019 miles we find 403 miles of what is generally known as "earth work," the greater part being light plow and scraper work. When we consider the means of access to this work (see further on) it will be readily seen that this will not cost more per mile to build than any real earth work in a mountain country. The 86 miles of hill side slopes consist of earth and loose rock and a few points of stratified sandstone. Almost all side cuts and fills are on flat slopes.

The 191 miles of rough talus slopes are of loose rock and boulders and earth—with slopes of stratified lime and sandstone—nearly all side hill work, and easily handled. The 99 miles of granite walls, while all solid rock excavation, is the cheapest class of such work. Almost the whole of it can be

THE MARBLE BENCH WORK BELOW KANAB WASH. (Photo. 600.)



THE MARBLE BENCH WORK IN DETAIL. (Photo. 608.)

thrown directly into the river without handling. As so much of it stands in slopes approaching 40 degrees only a minimum cross section will be necessary. The more abrupt portions, of course, are heavy. Yet these can be handled with powder with only a small amount of haul or handling. These same conditions, even in a greater degree, affect the cost of all the other rock work, both in the great canons and in the small canons below (except the two narrow points above noted), so that this solid rock work would not nearly approach the cost of such an amount where much of it would be through cutting.

The heavy embankments in the river would be very expensive to build.

The tunnel work would only be affected in cost by the inaccessibility of the country. And the total amount, 20 miles, when we consider the large amount of curvature and the distance—42 miles—saved, is not far in excess of such work on a number of already constructed roads.

One item affecting the cost of construction would be the expense of supplies and material during the progress of the work. The line starts at Grand Junction in a rich agricultural valley connected with the East and West by several railroads. Seventy-five and one hundred miles down on the Grand are well settled agricultural valleys connected by ordinary mountain roads. Between these points the Rio Grande Western Railroad comes to the river, about 40 miles below Grand Junction, and practically follows it for 30 miles further.

By the building of a wagon road five miles from Green River station, Utah (D. & R. G. W. R. R.), past the only rapid, supplies can be transported to the head of the Colorado River by steam launch and flats, a distance of 120 miles down the Green River.

Fifty and fifty-five miles down the Colorado, Crescent Creek and Dandy Crossing, are about 125 miles by wagon road from the D. & R. G. W. R. R., and these same wagon roads continue on down, and come to the river in a number of places in Glen Canon, at Smith's and Hall's ferries, and at several mining camps.

At Lee's Ferry the river is connected by wagon road with the Atlantic & Pacific R. R., at Flagstaff and with the farming country of lower Utah. From this latter road it is an easy matter to build roads to the top, and trails down to the river in Marble Canon—notably opposite Point Retreat. Such a trail already exists down the Nan-Co-Weap.

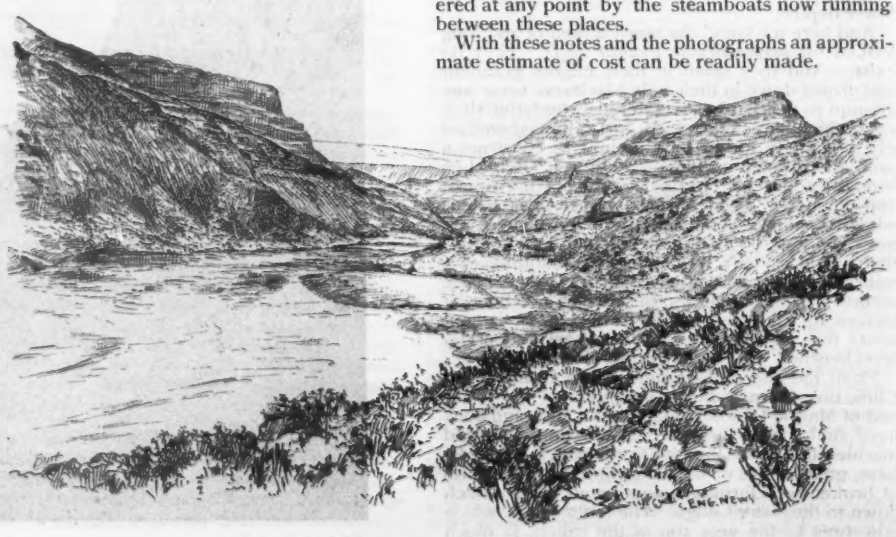
The Grand Canon is connected with Flagstaff, Arizona, by a wagon road on top, and a trail down to the river near the head of the canon, and the same down the Kanab from Utah.

At Diamond Creek is a good wagon road 24½ miles from the Peach Springs on the Atlantic and Pacific Railroad into the heart of the lower canon.

Below the canon is the old road and ferry at the Grand Wash and the roads and ferries at Scanlon's and the Rio Virgin, connecting both with the Atlantic and Pacific and the rich country around St. George and St. Thomas and that of southwestern Utah.

From the Rio Virgin to the Gulf the river is navigable, and supplies and material can be delivered at any point by the steamboats now running between these places.

With these notes and the photographs an approximate estimate of cost can be readily made.



THE GRAND CANON BELOW THE VOLCANO. (Photo. 659.)

The first of these we will now consider. The second (as promised above) will be taken up later.

It will be remembered that the original object in the projection of this railway, was to connect the coal fields of Colorado with the Pacific Coast. These very extensive coal fields are already connected with Grand Junction by rail.

The scarcity of cheap fuel upon the Pacific Coast is well known. The much larger proportion of the fuel used there being imported from foreign countries. The question first proposed was how to connect these two distant points so as to cheaply and profitably transport the abundant fuel of the one to the extensive fuel market of the other.

The transportation of such bulky material as coke and coal is perhaps most affected by the grades of the railway over which it is carried. First, then, as to the *grades*:

Starting from the town of Grand Junction, it is possible to build a railway with a continuous down grade the whole length of the line to the Gulf of California, and to have a returning grade with a maximum not exceeding 12 ft. per mile, except for a distance of 20 miles, and then it need not exceed 20 ft. per mile.

This is only the possibility of the case. I do not think it would be either advisable or economical to construct such a line.

From the surveys already made, I believe that in no place would it be necessary to use a grade in either direction to exceed one-half of one per cent. or 26.4 ft. per mile.

The following table gives the average fall of the river through the various sections. The distances are by the river and *not* by the survey.

THE GRAND CANON BELOW THE VOLCANO. (Photo. 643.)

THE GRAND CANON ABOVE THE VOLCANO. (Photo. 618.)

Divisions of Grand and Colorado Rivers.	Distances in miles.	Total fall in feet.	Average fall per mile.
Grand Junction to head of Colorado. . .	162.4	650	4.00
Cataract to Narrow Canons	55.	355	6.45
Glen Canon	150.	325	2.17
Marble Canon.	65.2	510	7.82
Grand Canon to the Granite	18.2	110	6.04
" " to Granite Falls	10.	210	21.00
" " to Powell's Plateau	26.4	330	12.13
" " around Powell's Plateau. .	10.8	100	9.26
" " to head of Kanab Division	4.8	50	10.42
" " Main Kanab & Winkaret Division	65.2	310	4.75
" " Sheavwits Division to Granite	12.	70	5.83
" " to Diamond Creek. . . .	18.	210	11.66
" " in Granite below Diamond Creek.	7.2	25	3.47
" " in Granite below Diamond Creek.	10.8	100	9.26
" " to Grand Wash	35.	175	5.00
From Grand Wash to Las Vegas Wash .	68.	300	4.41
Total to Las Vegas Wash	719.	3,830	5.31
From Las Vegas Wash to the Gulf, or to end of survey*	425.	700	1.64
Grand total	1,144.	4,530	4.00

*This last distance does not take in all the many windings among the Sand Islands in the lower part of the river.

Secondly, as to the alignment: The grand and Colorado Rivers are large streams, flowing as regards their detail, in long sweeps and gentle curves.

Reference has already been made to the sharper bends requiring tunnels.

From the surveys made I consider that a line can be located, and in an economical manner, with curves not to exceed 10°, or in other words with a radius of 573 ft.

Thirdly, as to terminus: it is not necessary at this time to take up the question of a proper Pacific Coast terminus, but we will consider that to be the port of San Diego. Surveys have been made (not by our company) from Yuma to San Diego, with a distance of 190 miles and grades of 90 ft. per mile concentrated into a short division.

Fourthly, as to the nature of the road-bed and the maintenance of the permanent way: Along those portions of the route where it will be necessary to construct the road-bed upon low flat-bottom lands, the river is broad and shallow and its fall is very light. This is noticeably the fact through Glen Canon where the greater part of such work occurs. These flats are above all ordinary high water; the line can be securely built across them, and rip-rap and material for slope wall protection can be easily and cheaply procured. In the same section where, as explained above, it is necessary to construct some miles of the road-bed in the river, under the cliffs, the same facts occur. The river is broad and level, and the difference between low and high-water is at a minimum. The embankments would be built almost entirely of solid rock, and the maintenance of these portions of the road would not exceed such work on any ordinary line along a large water course.

Along those portions of the canons where the walls are either solid rock trenches or what we have considered heavy talus slopes, it is a simple matter to locate the road-bed well above the most

THE GRANITE GORGE BELOW DIAMOND CREEK. (Photo. 673.)

THE GRANITE GORGE BELOW DIAMOND CREEK. (Photo. 732.)

extreme high water, and only in crossing a few of the larger side canons, would this cause any additional expense. Along the solid rock trenches and sloping walls of sandstone, marble and granite, the road-bed would be almost entirely in excavation. This would also be the case along a large proportion of the so-called talus slopes.

One notable fact is shown in the detailed description of the route—the almost entire absence of great slopes of loose rock or *slides*, which are generally so difficult and dangerous to handle. It is almost universally the case, as clearly shown by the photographs, that these talus slopes are composed of horizontally stratified rock in place, covered with a thin layer of loose debris, so that the road-bed, in almost its whole extent through the Canon division, would be built on solid and durable foundations.

The features peculiar to this route and affecting the maintenance of the road-bed remain to be considered, viz., the drainage across the road-bed, and the possible effect of loose material from the cliffs above.

In our survey and examination I took notes of all waterways from 10 ft. upward. These are not in excess of the necessary drainage of some of the existing railway lines. It is true that "the whole region is a labyrinth of stupendous lateral gorges from half a mile to a mile deep, and running back from the Colorado for many miles on both sides, as stated by Major POWELL. But it is also true that these great side gorges *enter* the Colorado through the lower and harder strata of compact sandstone, marble and granite. Many of them, which a little way back from the main chasm are from one to three miles wide on top, in cutting through these lower strata enter the river through narrow channels that can be spanned by from 50 to 100 ft. bridges. These are clearly shown by many of the photographs taken.

There are some exceptions to this (as instances the Nan-Co-weap and Kwagunt, branches of the Marble Canon) where the mouths of the side gorges have been washed out into wide flats. These do not present any more difficulties than the crossing of any wide water-course not in such a canon.

The smaller waterways in the rocky portions of the route are remarkably simple. The granite and marble give solid abutments on either side, and the channels are deep and narrow.

There is another feature of the drainage peculiar to such canon work. That is, the smaller streams that come over the tops of the cliffs. Where the canon is wider and talus slopes exist at the foot of the cliffs these small streams have worn out basins back next to the cliff, into which they fall, and from these can be carried under the road-bed in the natural channels that now exist. In many places where the road-bed is cut along the benches of the cliff these small streams (which only flow during storms) and the debris brought down with them can be carried *over the road* by a very simple device of overhead drains; so that the drainage does not present any insurmountable difficulties or any very difficult problems not found upon other mountain roads.

The question of falling rock and loose material from above is not different here from what obtains on hundreds and hundreds of miles of operated railroads through the Rocky Mountain region.

THE VALLEY BELOW THE GRAND CANON. (Photo. 756.)

IN THE LAST TEN MILES OF THE GRAND CANON. (Photo. 737.)

The immense width of the canon on top prevents the great mass of rock loosened from above by storms reaching the inner or lower gorge in a way to do any damage. The lower gorge is of a harder material and not so easily affected. It is true that masses of rock do come down, in the same manner as they reach the road-bed of the Colorado Central, the Denver & Rio Grande, and the Colorado Midland roads; but with this exception, that the lower levels of the great canons of the Colorado River are to a large extent exempt from the effects of long and hard freezing weather. During the whole of the eight months that I spent in the canons of the Colorado—including a whole winter—(with the exception of one storm) I only only saw or heard one single rock drop from their sides.

One feature largely affecting the maintenance of the permanent way, and also the traffic of such a road, is almost the entire absence of snow in winter from so large a portion of the line.

During the winter of 1889-90 we only experienced two hours of snow storm at the level of the river, while we could see that the whole upper plateau country was covered with (as we were told afterward) from 3 ft. to 6 ft. of snow.

I am aware that these are only the observations of a single winter; I am also aware that the river has been frozen over at Lee's Ferry so that wagons could cross; yet I am told by parties who have frequently been in the Grand Canon, at the mouth of the Kanab, that the great snow storms of the Kalbab Mountains never reach the bottom of the canon except in the form of mist, and this was our experience during the whole winter.

It may also be remembered that this winter of 1889-90 was one in which the transcontinental roads through the Western mountains suffered more from snow blockades than they had for many years previous.

We kept a careful register of the thermometer from Nov. 28, 1889, to May 1, 1890. A brief abstract of the record may be of interest:

THERMOMETER OBSERVATIONS.

Sections of the Route.	Max.	Min.	Average. 6 A.M.	Noon	6 P.M.
From Green River to Dandy Crossing, Nov. 28 to Dec. 10, 1889	65°	10°	34½°	52¾°	45¼°
Dandy Crossing to Lee's Ferry and to middle of Marble Cañon, Dec. 10 to Dec. 31, 1889	68°	30°	39¼°	54½°	47¾°
Month of January, 1890, in lower Marble and the Grand Cañons	68°	24°	37⅜°	48°	43°
In the Grand Cañon, Feb. 1 to March 17, 1890	82°	29°	47°	61½°	55°
End of Grand Cañon to Fort Mojave, March 17 to 23	76°	42°	52°	66°	61°
From Fort Mojave to the Needles, Yuma and the Gulf, March 23 to April 30	93°	40°	52°	83°	75°

Taking the whole line into consideration, when once properly built, it will not only not be highly expensive to maintain, but in many points will be far below the average of mountain railways, and in the matter of winter transportation would have advantages over any line crossing the country from the Rocky Mountains to the Pacific Coast.

GENERAL TABLE OF CLASSIFICATION IN MILES.

Divisions.	Level bottoms, earth and gravel slopes, "Earth work."	Hill side slopes, E. and L. R.	Rough talus, and slopes of L. R. and S. R. and boulders.	Smooth solid rock slopes.	Cliff bench work, sandstone and marble.	High cliff work. Not vertical.	Sloping and heavy Granite walls.	Heavy through rock cuts.	Heavy embankment in river.	Rock bluff in lower cañons.	Tunnels.	High vertical cliffs and half tunnels.	Totals.
Grand River	36.323	19.273	61.035	6.206	.....	.....	13.040	.....	.....	.....	4.110	.....	139.987
Cataract and narrow cañons	11 543	5.436	14.545	2.557	19.110	.....	.....	.....	.739	.....	.284	.....	54.214
Glen Cañon	57.270	10.928	55.926	21.284	.....	.....	.....	.501	6.553	.....	4.118	.....	156.580
Marble Cañon	.500	.....	26.510	.....	32.250	.....	.....	.125	.750	.....	2.375	.....	62.510
Grand Cañon	.....	51.050	43.750	1.250	30.600	3.000	85.925	.....	.200	.....	.875	.500	217.150
To the Rio Virgin	26.500	.....	.....	.....	.....	.....	.....	.....	.250	10.750	.....	.....	37.500
To Las Vegas, Wash.	16.500	.....	.....	.....	.....	.....	.....	.....	.....	11.500	.500	.....	28.500
To the Needles	67.750	.....	.....	.....	.....	.....	.....	.....	.....	27.750	1.000	.....	96.500
To Near Gulf or end of survey	197.255	.....	.....	.....	.....	.....	.....	.....	.....	47.500	.....	.....	244.755
Totals	413.641	86.687	201.766	31.297	81.960	3.000	98.965	.626	8.492	97.500	13.262	.500	1,037.696
If the long tunnel line in Glen Cañon is used: Totals	403.947	86.232	191.339	27.825	81.960	3.000	98.905	.570	7.356	97.500	20.002	.500	1,019.216

The scarcity of water through the same section that so affects the other transcontinental roads would be entirely done away with, the supply from the river being the best possible, when allowed a little time for the settlement of the sand.

All through the cañons, even in the narrow granite gorge, are found numerous flats and smooth hillsides for sidings, stations, repair shops and other necessary buildings, and even tracts large enough and well located for towns and villages. Whether these tracts will ever be occupied by towns or villages is a question to be answered under the head of possible business for the road.

When I shall take up that part of the subject I believe I shall be able to show a business now ready for such a road far in excess of what has been ready for many of our great railways *when built;* and also a country that would develop a *local* as well as a through business for the line, far in excess of what may be expected in the future on the same distance of some, at least, of our present transcontinental roads.

Graphic Diagram of Air Compression.

The theoretical diagram illustrated in Fig. 1 was made by the Ingersoll-Sergeant Rock Drill Co. to illustrate in a graphic manner the phenomena and effect of compressing air, in volumes, pressures and resulting temperatures, without cooling the air during the time of compressing.

The vertical and horizontal lines designate the various measures as registered by the numbers on each side, and at top and bottom. The adiabatic or heat curve commencing at the bottom and left hand passes to the right and upward, showing the amount of compression at any given gauge pressure by the decimal amounts marked across the top of the diagram, and the pressures by atmospheres by the figured column at the left, and pressure by gauge by the column at the right of the diagram.

The isothermal or cold curve, running also in the same direction and diverging for a part of its course from the heat curve, shows the approximate loss in percentage of volume or the volume when cooled to the normal temperature by the horizontal intersecting lines as read by the decimal proportions across the top of the diagram. These curves represent the theoretical effect of compressing air without the means of cooling the air in the compressor while being compressed.

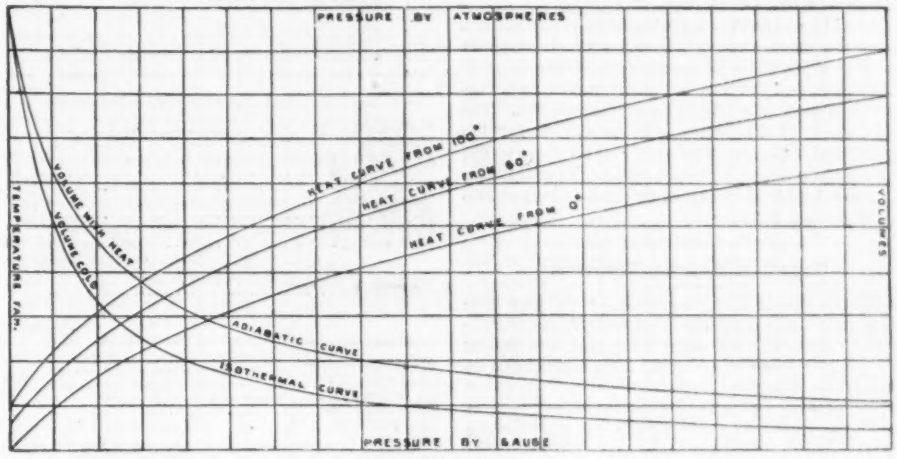


FIG. 1.

The three lines commencing at the right hand at the bottom of the diagram represent the actual temperature of compression starting from three different normal points, viz.: zero, 60° and 100° Fah. Their indications of the heat of compression for various pressures are noted at the intersection of the curve with the horizontal line for any given pressures and read in degrees by tracing the vertical line to the bottom of the diagram.

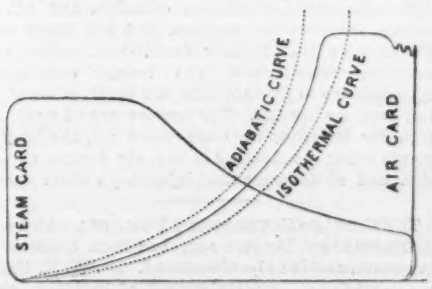


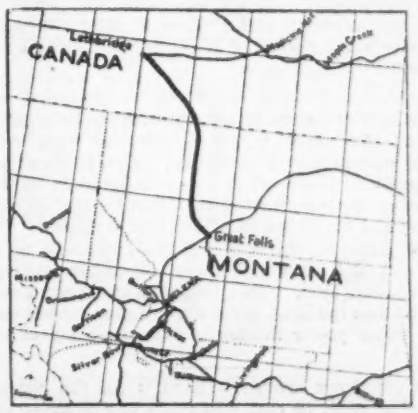
FIG. 2.

With any system of cooling of the air during compression the lines of the indicator cards can be traced between the adiabatic and isothermal curves, showing the efficiency of the system of cooling as compared with any other system of cooling—as by water injection and by variable proportions of surface cooling. Although water injection has given the best results as to economy of compression, the system has been generally rejected by builders of air compressors on account of the gritty and acid condition of the water necessarily used for injection in mining operations, where the bulk of compressed air is now used.

With the late improvements made by the Ingersoll-Sergeant Co. (Sergeant's patent), comprising the piston inlet, annular valves in the piston, and water jacketed cylinder heads with the water jacketed cylinder, the best results as to economy in every direction have been attained. In the air diagram of the combination card, Fig. 2, here illustrated, the curve of compression takes a median line between the adiabatic and isothermal lines as dotted on the card, showing, by actual trials, a higher efficiency than had before been obtained in water jacketed compressors.

The Great Falls & Canada Railway.

A local railway of more than ordinary importance has recently been opened for traffic by the Great Falls & Canada Ry. Co. This company was chartered late in 1889, and is the first of the several companies formed to connect the railways of the far Western States with the Canadian Pacific lines in the northwestern Canadian Provinces to bring this line to completion. The road is the outcome of several years' endeavor on the part of the owners of the Lethbridge, Alberta coal mines to obtain an outlet to the markets of the United States for their products, and is entirely independent of any of the large systems. Its route, as shown by the accompanying map, is from Great Falls, Mont., on the Great Northern Ry., northwest and north through northern Montana and southern Alberta to Lethbridge, the southern terminus of the Northwestern Coal & Navigation Ry., a total distance of 108 miles. Its surveys for the line were commenced early in March of the present year, and active work of construction began June 15. The road was completed Oct. 3. Its route being through a prairie country, the work was generally light, the only heavy grading being at the crossings of the Teton, Marias, and Milk rivers. Donald Grant & Co. were the contractors for building the road. The Illinois Steel Co. had the contract for the rails, the



Baldwin Locomotive Works for locomotives, Wells French & Co. for cars, and Pettibone, Mulliken & Co. for bolts and spikes.

The company was aided by the usual land grant of 6,400 acres per mile for the 65 miles in the Dominion. This section was built under the charter of the Alberta Coal & Railway Co., which owns and operates the coal mines at Lethbridge.

It would seem that the prospects of the road for a paying business were good. Its route is through a section of Montana containing considerable mineral wealth, and having sufficient agricultural resources to support a large mining population. The development of this region will ultimately furnish a good local business. The principal business of the road for the present, however, will be the coal traffic from the Lethbridge mines to the smelters at Helena and Great Falls.

Canadian Railway Progress.

The remarkable progress made in railway construction in Canada within little more than one generation is pointed out in a long and interesting article in the *Montreal Gazette*. This résumé can be tabulated as follows:

	Mileage.	Passeng'rs carried.	Freight moved—tons.	Earni'gs.	Working Exp'nses.
1837	16				
1842	16	27,041	7,716	$13,650	$10,744
1859	2,087	1,922,227		6,839,409	
1869	2,467			12,798,303	
1879	6,484	6,523,816	8,348,810	19,925,066	16,188,282
1889	12,628	12,151,105	17,928,626	42,149,615	31,038,045

Including government bonuses, loans, subscriptions to shares and municipal aid, the capital paid amounted to $700,576,446. The amount promised to railways, completed or under construction, in the shape of government and municipal loans, bonus, etc., is put down at $148,802,087.

An Arizona Natural Bridge.

The *Topeka Democrat* of Oct. 13 describes a natural bridge, said to be found on the property of DAVID GOWAN, in the northern part of Gila Co., Ariz. This "wonder" spans Pine Creek by a single arch of 200 ft., with walls on either side rising to a height of 700 to 800 ft. The bridge is 600 ft. wide, and the thickness of the arch is 40 ft., rise not stated. The account says that the rock is limestone, worn very smooth by the action of water. One part near the corner of the arch is only 6 ft. thick, and is pierced by an opening. Our correspondent who sends the cutting queries it with a "How is this?" We reply we have never heard of it before, and must await further developments.

MADISON LAKES, in Wisconsin, are to be lowered, and the work will commence at once, with an estimated cost of $60,000. This is about the biggest drainage scheme ever undertaken in the State. It is estimated that 27,000 acres of farm land and 80 city blocks will be thus reclaimed. The mill dams at Madison and Stoughton will be removed and main and lateral ditches cut through the marsh land. Some litigation is expected with parties on the Rock River who may sue for damages to water power incident to the lowering of the lakes.

NEW YORK STREET CLEANING for the quarter ending Sept. 30 cost $284,411.86, or $105,359.12 less than for the first quarter of 1890, and $83,111.95 less than for the second quarter. The area swept aggregated 314,179,328 sq. yds., and 355,461 cart loads of ashes and garbage were removed. Of this 19,850 loads were used for filling city lots and the remainder carried to the sea. The city received $13,886.60 for the privilege of trimming the scows. Fines amounting to $3,938 were collected.

TRAIN ROBBING IN RUSSIA is a new enterprise in that country, and the robbers seem to have copied closely the methods of their American brethren, according to accounts in the London *Railway News*. About two months ago the express train between Vladikavkas and Rostof was boarded by four men at night and the passengers in a first-class carriage were plundered. And, later still, an express train near Moscow was robbed by five armed men in broad daylight, the railway employés and passengers being overawed by revolvers in the good old style. Russia is progressing, and a much needed zest is being given to travel through that flat and uninteresting country.

ELEMENTS OF WEATHER IN THE UNITED STATES, OF MOST INTEREST TO ENGINEERS, FOR THE MONTH OF SEPTEMBER, 1890
[Furnished to ENGINEERING NEWS by the Chief Signal Officer, U. S. A.]

STATION.	Temperature. (Deg. Fah.) Average.	Max.	Min.	Range.	Wind. Velocity in miles per hour. Average.	Maxim.	Direction at time of max. velocity.	Precipitation.—Rain and melted snow. Inches. Total.	Heaviest in 24 hours.	Number of rainy days.
NORTHERN CITIES.										
Northfield, Vt	56.0	79	27	52	7.3	32	NE	2.95	.55	18
Portland, Me	59.7	79	37	42	7.2	27	S	4.88	2.11	13
New York City	66.8	86	46	40	9.3	25	N	7.21	4.30	11
Pittsburg, Pa	64.6	89	40	49	4.5	19	SW	4.24	1.58	14
Chicago, Ill	60.4	88	39	49	17.3	49	NW	1.39	.98	7
Omaha, Neb	62.7	94	36	58	7.0	34	NW	2.50	1.41	7
St. Paul, Minn	58.2	84	31	53	6.7	28	NW	2.73	.58	10
Duluth, Minn	55.1	81	35	46	7.5	34	NE	2.39	.85	12
Bismarck, N. Dak	56.4	88	26	62	10.4	42	NW	.98	.43	10
Average	60.0	85.3	35.2	50.1	8.6	32.2	.....	3.25	1.42	11.3
SOUTHERN CITIES.										
Washington City	67.8	87	44	43	5.3	24	NW	4.22	1.53	11
Louisville, Ky	68.0	91	46	45	6.0	24	NE	2.69	1.06	11
St. Louis, Mo	65.0	92	41	51	9.5	34	NW	1.80	.67	10
Savannah, Ga	75.4	88	58	30	4.8	28	NE	16.58	4.85	22
Leavenworth, Kan	64.0	88	37	51	4.5	36	NW	3.81	1.67	9
Jacksonville, Fla	79.1	92	65	27	4.4	28	SW	4.88	.97	20
Chattanooga, Tenn	71.5	90	55	35	3.7	21	NW	7.10	2.14	16
New Orleans, La	77.6	89	56	33	7.0	29	S	2.85	1.06	12
Memphis, Tenn	70.8	90	50	40	5.6	34	NW	9.07	4.50	18
Palestine, Tex	74.2	93	47	46	3.0	25	N	3.42	1.58	11
Average	71.3	90.0	49.9	40.1	5.4	28.3	.....	5.64	2.00	14.0
WESTERN CITIES.										
Helena, Mont	57.0	84	26	58	6.0	36	W	.58	.28	6
Port Angeles, Wash	*	*	*	*	*	*	*	*	*	*
San Francisco, Cal	60.4	81	52	29	8.0	26	W	.31	.30	2
Salt Lake City, Utah	65.0	87	39	48	3.9	30	SW	Trace	Trace	0
Denver, Col	62.5	87	34	53	6.5	36	W	.17	.10	5
Yuma, Ariz	87.7	110	67	43	5.9	36	NE	.64	.64	1
Santa Fé, N. Mex	60.9	82	42	40	5.7	32	NE	.89	.24	9
Average	65.6	88.5	43.3	45.2	6.0	32.5	.....	.43	.26	3.8

* Report not received.

AN OVERHEAD ELECTRIC RAILWAY for the conveyance of traveling letter boxes is to be opened between Buenos Ayres and Montevideo this month, says our exchanges. The line is 186 miles long, and it crosses the estuary of La Plata, with the wire supported on two towers 260 ft. high. Boxes are to be despatched every two hours.

COMPRESSED AIR FOR POWER DISTRIBUTION, for Dresden, is elaborately set forth in a pamphlet describing a scheme proposed by Dr. R. PROELL. The erection of steam boilers is prohibited within the city limits, and high-tension electric currents were objectionable. The pamphlet gives in detail a project for supplying 7,500 I. HP. Ten triple expansion condensing engines working under 150 lbs. initial pressure, of 750 HP. each, are provided for. The air-compressors have 27½-in. cylinders and 49.2-in. stroke, same as the engines, and are fitted with Proell valve gear, Riedler double-beat valves, and external water-jacket. The twenty compressor cylinders are to produce 2,200,000 cu. ft. of air of 120 lbs. pressure per day. The motors are of novel design for utilizing the compressed air, the leading points being the heating of the air during expansion and at the same time injecting a water spray.

THE CHICAGO GOVERNMENT BUILDING, which cost $6,000,000 about 14 years ago, has been condemned as unsafe, and is to be abandoned. Mr. W. K. BELL, the government superintendent of buildings, says that during the past 13 years the structure has settled from 6 to 18 ins., and has settled from ¼ to ½ in. in the past few days. The number of employés in and about the building is stated to be "about 3,600."

THE NICKEL APPROPRIATION of $1,000,000, as ordered by the late Congress for armor plate, has resulted in the discovery that there are only about a dozen nickel mines in the world, and only three are on this continent. The output of these mines is doubtful, and one source may not be sufficient. Other nations may also see the advantages of the new alloy, and it is said that KRUPP's representative is already seeking to gain possession of the Canadian mine. The other two American mines are in Nevada and in Lancaster Co., Pennsylvania.

A USEFUL ALLOY of ALUMINUM is made by M. BOURBOUZE by fusing together 100 parts of aluminum and 10 parts tin. This alloy is paler than aluminum and has a specific gravity of 2.85, or a little more than the pure metal. It is not so easily attacked by the several reagents as aluminum, is more readily worked and can be soldered as easily as bronze without further preliminary preparation.

CHEAP TRANSPORTATION, of the kind, is described by the late Mr. THOMAS in his book on famines in India. He says that the natives of Malabar take a tree 60 ft. long and 2½ ft. wide and hollow it out into a canoe, with the opening above so narrow as to be closed by a plank. This canoe will hold 5 tons of grain and this is poled down the rivers and canals by a man and a boy at the rate of 30 miles in 24 hours for 18 cts. This is about ½ ct. per ton-mile. Some American railways transport coal at the rate of ¼ mill per ton-mile.

THE STATE GEOLOGICAL SURVEY OF MISSOURI, according to the last report of Mr. ARTHUR WINSLOW, State Geologist, is in active progress. The examination of the clays and structural materials in and about Kansas City is the most important work on hand. There are in and about this city 32 works making clay products and 15 to 20 quarries.

THE ERYGMATOSCOPE is an instrument designed by M. TROUVE, and described in *Le Genie Civil*, for the examination of geological strata pierced by deep boring. The apparatus consists simply of a powerful electric incandescent lamp, inclosed in a cylindrical case, one of whose curved sides serves as a reflector, and the other, made of thick glass, permits the illumination of the bore hole. An elliptical mirror, set at the bottom of the case, throws its

images vertically upward through the open top of the case to the observer, who examines them with a powerful telescope. It is said that the apparatus works satisfactorily "to a depth of 1,000 ft." and that the Portuguese government has supplied it to its expedition that is exploring the shores of Mozambique.

THE MASTER CAR-BUILDERS' LETTER BALLOT has resulted as follows:

SUBJECTS VOTED ON.	Question.	Number votes cast. Affirmative.	Negative.	Total.	No. votes necessary for adoption.	Results of votes.
Journal box for cars of 60,000 lbs. capacity	a	299	249	548	366	Rejected.
Lid for 40,000 lbs. capacity journal box	b	297	251	548	366	"
Loading logs and poles on cars	c	539	1	540	360	Adopted.
Racking cars for loading bark	d	467	53	520	347	"
Height drawbar passenger equipment cars, 35 ins.	e	539	8	547	365	"
Safety chains for passenger equipment cars	f	449	108	548	366	"
Brake-beam lever, lateral angle 40°	g	502	41	543	362	"
Fitting for train pipe for steam heat 2-in. female, standard pipe thread	h	390	146	536	358	"

THE FAIR COMPANY in Chicago has let the contract for the erection of a $3,000,000 16-story building for mercantile purposes. This structure is to be erected in sections as the site is improved. Steel, plate glass and terra cotta will be used as materials of construction, and it will be fireproof. Twenty-two elevators will provide means of access. The architect is Mr. W. L. B. Jenney.

THE WORLD'S FAIR COMMISSION have formally accepted from the South Park Commissioners their offer of September, 1890, giving the use of Washington Park for the purposes of the Exhibition of 1892. This is on the lake front.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Evansville & Terra Haute.—The section of the Evansville & Richmond R.R., running from Sand Creek, Ind., to the Vernon, Greensburg & Rushville R.R., 17¼ miles, will be opened for traffic Dec. 1.

Columbus, Shawnee & Hocking.—Tracklaying has been completed on the line from Reed's Station to Saltillo, O., and the road put in operation. The line connects the Columbus & Eastern and Shawnee & Muskingum divisions of the road.

Toledo, Findlay & Springfield.—The survey for the extension of this road from North Baltimore, O., to Findley, O., has been completed and estimates for the construction made. It is intended to commence work at once.

Saratoga & St. Lawrence.—At a recent meeting of the directors it was decided to extend this road from Bombay, N. Y., to the St. Lawrence River at Hogansburg, N. Y., a distance of 8 miles. Work will be begun next season.

Penobscot Shore Line.—This company proposes to expend $300,000 on the recently purchased Knox & Lincoln R. R. in improvements. The company has made a proposition to build a line from Warren to Camden, Me., on condition that the people along the route subscribe $25,000 in aid of the enterprise.

Michigan Central.—The contract for extending the Hampton logging branch into the Boyce timber district, a distance of 12 miles, has been let to John M. Lally. A large force will be put at work at once, in order to complete as much of the line as possible by Jan. 1.

Long Island.—This company is contemplating a change of route for its line from Woodbury to Northport, N. Y.

Pittsburg, Akron & Western.—All but 12 miles of the line from Curry to Akron, O., has been graded, and work on this section is in progress. Tracklaying has been completed from Curry east to Rock River, 84 miles. It is expected that the remaining 25 miles to Akron will be completed by Jan. 1.

Croton Valley.—The contract for building this road has been let to Ripley & Coffin, 50 Broadway, New York City.

Concord & Montreal.—Grading has been completed on the Franklin & Tilton R. R., running from Franklin to Tilton, N. H., 4.93 miles.

Ottawa & Gatineau Valley.—Tracklaying has been completed from Ottawa to Ironsides, Ont., and work is progressing favorably.

Phillips & Rangeley.—The track has been laid on this road from Phillips to Redington Lumber Co.'s mills, a distance of 16 miles.

Couderport & Port Allegheny, R. R.—Surveys have been completed for an extension of this road to Galeton, a distance of 20 miles, by Mr. Thomas J. Rogers. It is reported as probable that the road will be constructed this winter.

Philadelphia & Reading.—Reports are again in circulation that the necessary arrangements have been completed for constructing the proposed line from Bound Brook to Perth Amboy, N. J.

Toledo & Ohio Central.—This company has secured control of the Kanawha & Michigan Ry., and will, it is stated, extend it about 100 miles.

New York.—A press dispatch contains the following:

Several railway schemes are being developed in the northern part of New York State. Two surveying parties, representing two different companies, have been running a line from Gouverneur to Edwards, a distance of about 15 miles up into the woods. The Rome, Watertown & Ogdensburg R.R. is interested in one of the lines, and several Syracuse men are pushing the other. The Gouverneur and Edwards road will connect with the road running from Moira Junction into the Adirondacks, tapping the Central at some point. The second line is a short through line from Ottawa to New York. The scheme is to connect with the Canadian Pacific at Waddington, below Ogdensburg, and bridge the St. Lawrence at that point. Potsdam people are interested in the proposed line, which will run through that place to Colton, and connect with the road at North Creek, thence through the Adirondacks to Schenectady, where connection will be made with the Central. Instead of building an entirely new line, connection will be had with the Delaware & Hudson road. These two roads would open up a territory which has long been waiting for a railroad. The third line is to connect with the Elmira, Cortland & Northern at Camden, and run from there direct north to Watertown, thence to Antwerp and Gouverneur, and connect with the Canadian Pacific at some point on the St Lawrence. This will come in direct competition with the Rome, Watertown & Ogdensburg. The immense mining interests of Northern New York afford a large amount of freight traffic, and these industries are now crippled by the high freight charges. Austin Corbin, President of the Philadelphia & Reading, is largely interested in this road, and has offered to take 10% of the stock. The citizens of Watertown are pushing the project and have held several meetings. An organization will soon be perfected.

Projects and Surveys.

Davenport, Middleburg & Durham.—At a meeting of the directors recently held it was decided to begin work at once on this road. The line is projected to run from East Davenport to Durham, N. Y.

Moosilauke.—A new survey is being made for the proposed railway to the summit of Mt. Moosilauke, N. H.

Marblehead & Danbury.—The surveys have been completed for this proposed railway from Marblehead to Danbury, Conn., 10 miles. Work will be commenced at once, and it is expected to have the road completed by Jan. 1. The Lake Shore & Michigan Southern R. R. will operate the line when completed.

Lake Hopatcong.—The contract for building this proposed New Jersey road is reported let to C. W. Leavitt, of New York City.

Buffalo, Thousand Islands & Pacific.—The surveys have been completed by Engineers F. G. Sikes and G. R. Sikes for this railway from Suspension Bridge to Buffalo, N. Y., 24 miles. F. R. Bicker, Weed Block, Buffalo, N. Y., is Chief Engineer.

Syracuse & Norwich.—A press dispatch says:

The railway that was begun 15 years ago from Syracuse, N. Y., to Norwich by the way of McGrawville, Solon, Cincinnatus, Pitcher & Otselic, is to be completed. The road was graded most of the way to Cincinnatus, and some of the bridges were built. Now a banker of New York has offered to advance $70,000 and to take first mortgage bonds. It is thought that this will build and equip the road. The right of way must be secured free and clear, and the old company are to transfer all their right and title to the new company, which is to complete the road by Jan. 1, 1892.

Terre Haute, Bridgeton, Bainbridge & Ft. Wayne.—Steps are being taken to secure the right of way for this railway, and it is stated that it will be built soon.

Maine.—A charter will be asked for at the next session of the State Legislature for a railway to run from the Maine Central R. R., in Hancock Co., to a point on the St. Croix River, in Washington Co.

SOUTHERN.—Existing Roads.

Ohio River.—Work on the Ravenswood, Spencer & Glenville R. R. is making very satisfactory progress. For the present the line will be built only from Ravenswood to Spencer, about 30 miles. It is expected to have this division completed by April 1, 1891. Stanley & Abels, of W. Va., are the contractors.

Albany, Florida & Northern.—Grading is being pushed on the division from Cordele to the Flint River and tracklaying has begun. The contractors for laying the track are Lawrence & Livingston. Work will soon begin on the division from the Flint River to Albany, Ga., and it is expected that the entire line will be completed this season.

Paducah, Tennessee & Alabama.—An official of this company writes us that the 50 miles of this road from Paducah, Ky., to the Tennessee State line was constructed in 84 days. This work included bridging, tracklaying, and the construction of all buildings. The route is through a heavily timbered and rolling prairie country. About 370 acres of timber land were cleared, 1,900 piles were driven, and 98 trestles were built. The roadbed is lined with white oak and part oak tires and 60-lb. steel rail. The road is now under construction from the State line to Paris, Tenn. Its southern terminus will be Florence, Ala. Johnson Bros. & Faught, of St. Elmo, Ill., are the general contractors, and S. M. Carter & Co., of St. Louis, Mo., are contractors for bridge work. N. R. Alcott, of Paducah, Ky., is Chief Engineer.

Savannah, Americus & Montgomery.—We have received the following from R. E. Hurdaway, Huntsville, Ala., Chief Engineer:

About 300 men and 200 mules are now at work on the extension of this road from Louvale, Ga., to Montgomery, Ala., a distance of 95½ miles. Of this distance 14½ miles are in Georgia and 81 miles are in Alabama. Twenty-five miles of the grading have been completed. It is expected that tracklaying will begin soon and the road completed by July 1, 1891. The route is through an open farming country affording easy work; maximum grade 1% and maximum curve 4°. There will be a bridge across the Chattahoochee with a 230-ft. draw span. The Georgia & Alabama Construction Co. has the contract for all work and materials except the rails. The principal business of the road will be in cotton, timber, minerals and general merchandise.

Watauga Valley.—Durand & Murphy have the contract for building this road from Carters, Tenn., to the East Tennessee & Western North Carolina R. R., 5 miles. The road is being built to develop the mineral resources along its route.

Wilmington, Onslow & East Carolina.—The grading on this road has been completed to Jacksonville, N. C., 50 miles from Wilmington, and 38 miles of track have been laid.

Roanoke & Southern.—Construction has been commenced at Roanoke, Va., and the work is to be pushed.

Macon & Atlantic.—It is stated that the eastern terminus of this road will be at Colleton, Ga., which lies on an arm of Port Royal Sound. A dispatch says:

The company has bought 5,000 acres of land at Colleton, and proposes to build a big city, with docks, naval stores, depots, grain elevators, coaling station, etc.

Projects and Surveys.

Charleston, Kentucky & Western.—A correspondent writes:

This company has been organized to build a railway from Newport, Ky., to Cumberland Gap, Tenn. The route is through a rich mineral section of the country. It is probable that construction will commence in the near future.

West Virginia & Pennsylvania.—It is announced that right of way is being secured for this road from Rowlesburg, W. Va., to Fairchance, Pa., and that construction will commence soon.

Virginia & Kentucky.—A construction company has been organized to construct this railway from Danville, Va., to the Kentucky State line, 200 miles. The officers are: President, Jas. A. Walker; Vice-President, W. N. Ruffin, Danville, Va.; C. E. Wortham, General Manager, Richmond, Va.

Potomac, Blackwater & Greenbrier.—Chartered in West Virginia to build a railway from Romney, W. Va., along the south branch of the Potomac to Petersburg, Grant Co., thence along the north fork of South Branch River to a point where the counties of Pocahontas, Pendleton and Randolph meet, and thence by three separate lines through the ore and lumber region, one passing through Greenbrier White Sulphur Springs. Three other branches are also projected.

Wilmington, Chadbourn & Conway.—The directors have decided to build a branch from Chadbourn, N. C., to mills in the vicinity.

NORTHWEST.—Existing Roads.

Duluth, Red Wing & Southern.—The Duluth Construction Co., recently organized to construct this railway, will, it is stated, begin work at once.

Milwaukee, Lake Shore & Western.—The contract for building the line from Interior Junction to the Duluth, South Shore & Atlantic Ry., a distance of 13 miles, has been let to Henry & Balch, of Minneapolis, Minn.

Duluth, South Shore & Atlantic.—Surveys are in progress for a line of railway from Cascade, Mich., to some point on the Minneapolis, St. Paul & Sault Ste Marie Ry.

Chicago & Northwestern.—The 900-ft. tunnel on the line from Whitewood to Deadwood, S. Dak., has been "holed" and will soon be ready for tracklaying. The material penetrated was rock.

Winona & Southwestern.—Rapid progress is being made on the grading of this road and it is expected to have the line completed to Osage, Ia., by Dec. 15.

Wadena & Park Rapids.—A large force of men is at work on this line from Wadena to Park Rapids, Minn., 36 miles.

Forest City & Southwestern.—The rolling stock and other equipment for this railway have been purchased and the road will be put in operation soon. It is proposed to extend the line from Forest City to Rapid City, S. Dak. Surveys will commence soon.

Chicago, Rock Island & Pacific.—Tracklaying is now completed between Papillion and South Bend, Neb.

Projects and Surveys.

Chicago, Des Moines & Pacific.—It is stated that this company is negotiating for the line of the Wabash R. R. between Des Moines and Harvey, Ia., 50 miles, and will make it part of its proposed line.

Dakota, Wyoming & Missouri River.—Chartered in South Dakota to build a railway from Rapid City, S. Dak., to Hill City and thence west through the Wyoming oil and coal fields.

SOUTHWEST Existing—Roads.

Haines, Hamilton & Kingston.—This Missouri road was opened for traffic Oct. 15.

Weatherford, Mineral Wells & Northwestern.—The grading is nearly completed on this road from Weatherford to Mineral Wells, Tex., a distance of 30 miles, and tracklaying is in progress.

Chicago, Kansas City & Texas.—It is stated that the money necessary to build this railway from Smithville, Mo., to the Iowa State line, has been secured and that the road will be soon built.

Projects and Surveys.

Beebe, Des Arc & Brinkley.—J. P. Lewis, Beebe, Ark., General Manager, writes as follows:

Work will begin during the winter on this road from Beebe to Brinkley, Ark., 38 miles. The route is through heavily timbered country, and the principal traffic will be in timber and cotton. Most of the right of way has been obtained, and $30,000 local aid secured. The road will be easy to construct.

ROCKY MT. AND PACIFIC.—Existing Roads.

Pecos Valley.—About 45 miles of track have been laid on this New Mexico railway and it is expected to have the line completed to Eddy, N. Mex., by Nov. 1.

Puget Sound & Grays Harbor.—Work has been commenced on a 3-mile logging branch toward Union City, Wash.

Lake Washington Belt.—About 600 men are now at work on the belt line along the shore of Lake Washington and tracklaying is in progress.

Union Pacific.—This company, it is stated, will extend its Nampa branch to Spokane Falls, Wash.

Denver & Rio Grande.—Surveys are making favorable progress on the Parry Peak cut-off from Sedalia, Colo., up Plum Creek to a connection with the main line.

Northern Pacific.—Additional forces are being put at work on the Green River & Northern R. R. from Durham, Wash., north.——Surveys are in progress for an extension from the Northern Pacific & Montana R. R. to the main line at a point between Thompson Falls and Horse Plains in Montana.

Southern Pacific.—This company is reported to be considering the purchase of the Astoria & South Coast R. R.

Wallace & Sunset.—J. R. Stephens, of Wallace, Idaho, Chief Engineer, writes as follows:

This road is projected to run from Wallace, Shoshone Co., Idaho, up Nine Mile Creek, a distance of 5 miles. Only 3.5 miles will be built at present. The work is generly light, with 2.5% grades for 2 miles and 3.5% grades for the remaining distance. Woods, Larson & Co., of Missoula, Mont., have the contract, the road to be completed Dec. 1. Geo. W. Dickinson is President.

Tacoma & Northwestern.—Ogden & Bosworth of Tacoma, Wash., Civil Engineers, write as follows:

This road is projected to run from Tacoma, Wash., north and west to Port Angeles, Wash., with a branch from the main line in Chimacum Valley to Port Townsend, Wash., a total distance of 115 miles. About 30 miles of the preliminarysurvey have been completed. The work will be generally easy; grades probably not exceeding 1.5%. The principal business of the road will be in lumber, minerals and farm produce. Frank C. Ross of Tacoma, Wash., is President.

Projects and Surveys.

Wyoming, Salt Lake & California.—A press dispatch says:

Bonds for the railway from Salt Lake City to Deep Creek, Nevada, have been secured in the east by J. H. Bacon, President of the Bank of Salt Lake, and the City Council will be asked to grant a right of way into the city with a 99-year lease of the Sixth ward square for $1 per year. Two hundred thousand dollars worth of bonds are taken in Salt Lake, and the management is entirely local. The line will be 165 miles long and standard gauge, is bonded for $18,000 per mile, and is to be built within 18 months. The company has absorbed the Wyoming, Salt Lake & California road with all its surveys, partially completed grades, maps, data, etc., so that the matter of building is much simplified. The object of the road is to connect Salt Lake City with the rich mining camps near the Nevada line, and thus bring here direct enormous quantities of ores. Three million dollars will cover all costs of construction.

Victoria, Port Crescent & Chehalis.—Bids are asked for clearing the first 12 miles section of this road from Port Crescent, Wash.

FOREIGN.

Siberia.—Dispatches from St. Petersburg say:

The *Novoe Vremya* says that the Russian Government will immediately begin the construction of the Siberian Ry. Officials of the government will have entire charge of the work, and no contractors will be employed.

Midland Great Western.—The English Government has advanced the Midland Great Western Ry. Co. of Ireland £400,000 for the purpose of enabling the company to build lines to connect the coast with inland markets in the distressed districts of Ireland. It is stated that 50 miles of line will be constructed from Galway to Clifden; 26 miles from West Port to Mulvanyn, and a short line from Ballina to Killalela.

CITY TRANSIT.

Electric Railways.—New lines or extensions are proposed in the following places: Rochester and Durham, N. Y.; Fay Ridge, Md., address Chesapeake & Columbia Investment Co., Washington, D. C.; Lynchburg, Va.; Wytheville, Va., address Wytheville Development Co.; Wilmington, N. C., E. L. Hawks can give information; Tredega, Ala., address the Jacksonville, Ala., Mining & Mfg. Co.; Clarksville, Tenn., address P. Johnson; Bloomington, Centralia and Waukegan, Ill.; St. Louis, Mo., address the Benton-Bellefontaine Ry.; Georgetown, Tex.; Eugene and Portland, Ore.

Springfield, Mass.—The directors of the Street Railway Co. have decided to call a meeting of the stockholders to vote on increasing the capital stock and introducing the electric system on all lines.

Hartford, Conn.—The Hartford & Wethersfield Horse R. R. has applied for permission to use an electric system on its lines.

New Haven, Conn.—There is some talk of abolishing the city regulation against trolley wires and introducing the overhead system on the lines of the Fair Haven & Westville Horse Car Co.

Niagara Falls, N. Y.—The right of way for a 7-mile electric line, the Niagara River Street Ry., is being obtained.

Lewiston, N. Y.—The Niagara Falls & Lewiston R. R. has been incorporated to build about 7 miles of electric railway along the east shore of Niagara River. G. A. Ricker, the engineer of the company, writes as follows:

The preliminary line is now being run; it follows the lower edge of the bank about 18 ft. above the highest water line. Progress is very difficult; the average day's work has been, so far, 685 ft. with party of seven. Brush is very thick, with fallen trees and heavy network of vines. The footing could scarcely be worse; rocks are wet and slimy, or loose and crumbling, ropes are constantly used for hoisting or lowering both men and instruments. It is very dangerous climbing, and the noise near the rapids below the whirlpool is almost deafening.

Reading, Pa.—It is reported that $50,000 have been subscribed to build an electric railway to Mohnsville, a distance of 5 miles.

Gadsden, Ala.—It is reported that the Gadsden & Attalla Dummy Line will adopt electricity as a motive power.

Athens, Ga.—The Athens Ry. Co., J. T. Voss, manager, will probably extend its line and change to an electric road.

Columbus, Ga.—The Columbus R. R. will probably operate its road by electricity.

Mt. Sterling, Ky.—A company will be formed soon to construct and operate an electric street railway for which a franchise has already been obtained.

Corunna, Mich.—Three applications have been presented for a franchise to build electric car lines.

Racine, Wis.—The Bell City Street R. R. was recently sold to a syndicate for $100,000. The company will probably put in an electric plant and carry out improvements raising the total value of the plant to $225,000.

Montclair, Colo.—The Electric Railway Co. has contracted with the Sprague Electric Co. for its electrical machinery, and the Woeber Carriage Co., Denver, for 5 motor and 10 trail cars.

Texarkana, Ark.—The Texarkana Street Ry. has been bought by the Gas and Electric Ry. Co., which proposes equipping the line with a $40,000 electric plant.

Beaumont, Tex.—The Beaumont Ice, Light & Refrigerating Co. is said to be forming a stock company to build a road.

Taylor, Tex.—The Taylor Street Ry. has been incorporated by A. T. Doak, J. A. Gano and A. L. Penn, with a capital stock of $20,000.

San Mateo, Cal.—B. Joost, W. P. Thomas, J. W. Hartzell, and others, have received a franchise for an electric line.

Horse Railway.—***Buena Vista, Va.***—The Street Ry. Co. will lay two or three miles of track.

Ruston, La.—The construction of a street railway is proposed.

Inclined Railway.—***Chattanooga, Tenn.***—M. M. Henderson, C. S. Henry and others have chartered a company to construct an inclined railway on Lookout Mountain and street lines in this city.

Cable Railway.—***New York City.***—The New York City Suburban Surface R. R. has received permission from the Board of Aldermen to build a cable or electric line through the upper part of Manhattan Island and in portions of the annexed district.

New Companies.—Opelika & Auburn Street Ry. & Dummy Line Co., Opelika, Ala.; Opelika, Ala., Street Ry.; Dallas & Ellendale Ry., Dallas, Ore.; incorporators, F. Hobart, E. Hobart and T. Morgan; capital stock, $20,000.

BRIDGES, TUNNELS AND CANALS.

Bridges—***Saco, Me.***—The city government has authorized a committee to contract for a new iron bridge to Factory Island.

Hancock, Md.—The Groton Bridge & Mfg. Co. have the contract for the bridge across the Potomac River at this place. The contract price is $35,000.

Augusta, Ga.—Grant & Williams, 9½ Peachtree St., Atlanta, Ga., will receive bids until Oct. 20 for the construction of the steel bridge across the Savannah River for the North Augusta Land Co.

Dublin, Ga.—John F. Duncan will receive bids until Oct. 20 for constructing an iron bridge, 320x18 ft., across the Oconee River, also for building approaches, 800x18 ft., for the bridge.

Florence, Ala.—The new Memphis & Charleston R. R. swing bridge across the Tennessee River, at this point, was swung Oct. 9. The bridge is of Alabama steel and iron 412 ft. long. The structure cost about $100,000 and has been about 16 months in building.

Atchison, Kan.—A pontoon bridge across the Missouri River is talked of.

Portland, Ore.—The plans for the Union Pacific Ry. bridge at this place have been approved by the Secretary of War. The bridge will be of steel with a 470-ft. draw.

Canals.—The surveys for the Pennsylvania ship canal have been completed. The canal is to run from the Beaver River to Lake Erie, and is estimated to cost $25,000,000.

WATER-WORKS.

NEW ENGLAND.

Middlebury, Vt.—The contract for the construction of the works has been awarded to Lang, Goodhue & Co. Burlington, Vt., for about $36,000. The contract includes filter beds, a pumping station with two turbine wheels and a 2,000,000-gall. pump, 8 miles of pipe, 50 hydrants and 50 valves. The pipe will not be laid until next spring.

Boston, Mass.—The $250,000 water loan mentioned last week will bear 4% interest.

Fall River, Mass.—The Watuppa Reservoir Co. is trying to reopen the suit against the city regarding the latter's water supply.

Lowell, Mass.—A $60,000 appropriation for a new pumping engine is before the Council.

North Brookfield, Mass.—The citizen's meeting to vote on the building of works by the town will be held Oct. 21. It is proposed to borrow $50,000, payable in the course of 10 years.

Willimansett, Mass.—The people will petition for a supply from the Chicopee water-works. Previously there has been talk of damming a brook above the village for a gravity supply.

Woonsocket and Manville, R. I.—The Woonsocket Water Commissioners have been authorized to extend their mains to Manville, provided the extension does not cost over $25,000 and at least $1,650 revenue can be secured.

MIDDLE.

Brooklyn, N. Y.—Three per cent. water bonds to the amount of $1,000,000 were sold Oct. 15, as follows: $500,000 due Jan. 1, 1906, to John H. Bonnington, at 100¼; $500,000 due Jan. 1, 1905, to Moeller & Co., New York, at par. The bonds are subject to local taxation.

East Aurora, N. Y.—The contract for the new works has been let to C. J. Shuttleworth for $34,906, and construction has been started, with George Kellogg, of Springville, as superintendent. The contract calls for the completion of the works by Jan. 1, 1891. Gathering pipes will convey the water from springs to a reservoir, from which a 10-in. force main will lead to the town, the surplus passing to a reservoir of about 100,000 galls. capacity. There will be 10,500 ft. of 8, 1,700 ft. of 6, 26,500 ft. of 4-in. pipe, between 50 and 60 hydrants, and a 750,000-gall. pump.

Ellicottville, N. Y.—The new reservoir has been filled. Distributing mains have not yet been laid.

Medina, N. Y.—Bassett Bros., of Buffalo, will begin the construction of works at once.

Gloversville, N. Y.—The mains will be extended. The Potter reservoir leaks badly, and water will be drawn down below the break.

Holly and Brockport, N. Y.—A system of water supply for these towns is being put in by Bassett Bros., Buffalo, N. Y.

Hoosick Falls, N. Y.—A well 24 ft. across and 40 ft. deep has been dug by Abner Quitterfield for fire protection.

Huntington, L. I., N. Y.—It seems probable that the Town Board will grant a franchise for works to a local company.

Rochester, N. Y.—Investigation for a new supply conduit are still being carried on, at present under the direction of the new city engineer, Emil Kuichling.

Schoharie, N. Y.—The mains are being laid by C. C. Kromer.

Syracuse, N. Y.—The Water Commission will at once begin work upon the Skaneateles Lake project for a system of water supply. On Oct. 9 Moeler & Co., of New York, paid in $250,000 of the $500,000 of bonds subscribed some time ago. The remaining $250,000 was to be paid this week. The price was 100 3-16. The total loan authorized is $3,000,000. The city is now supplied by the Syracuse Water Co., whose works are described in the 1889-90 *Manual of American Water-Works*. There has been much opposition to the construction of works by the city.

Crawford, N. J.—The following is from Wolcott C. Foster, 52 Broadway, New York:

It is proposed to begin construction early next year. The supply will be pumped from driven wells to a stand-pipe at an estimated cost of $50,000. Population, 1,500.

Madison, N. J.—Moffett, Hodgkins & Clarke, of Syracuse, N. Y., contractors for the new works, have awarded contracts for supplies as follows:

Stand-pipe, 25 ft. in diameter by 75 ft. high, and two 80-HP. boilers, Phœnix Foundry & Machine Co., of Syracuse; pumping machinery, 1,000,000 galls. daily capacity, Deare Steam Pump Works, of Holyoke, Mass.; valves, 45, 10 to 4-in., Rensselaer Mfg Co., of Troy, N. Y.; hydrants, double nozzle, 48 with 6-in. and 17 with 4-in. connection, Holyoke Hydrant Co., of Holyoke, Mass.; pipe, 48,863 ft. 10 to 4-in., Jackson & Wooden Mfg. Co., Berwick, Pa. Water will be pumped from a dug well.

Passaic, N. J.—The supply hereafter will be from a reservoir on Garrett's Mountain, fed by springs, instead of from Vreeland Lake and the Passaic River. The change increases both the pressure and purity of the supply.

Rutherford, N. J.—It is stated that a company has recently applied for a 30-years franchise, offering to furnish water to 75 hydrants at $35, and to houses at $15 each. The proposed supply is artesian wells or the Saddle River, a tributary of the Passaic. The Hackensack Water Co. has withdrawn its proposition.

Lemont, Pa.—The North Union Water Co., composed of Pittsburgh parties, has applied for a charter or franchise to supply the new coke works and the town.

Allegheny, Pa.—Sentiment seems to be strong in favor of a filtering plant in connection with the new works. Four bids for filtering plants, ranging from $240,000 to $369,000, have been received. Superintendent Edward Armstrong is reported as favoring, above the others, the filtering plant of the Municipal Water Supply Co., of Philadelphia, which is described as a gravity plant. This company's bid for filter was $340,000. If a filtering plant is not put in a large reservoir is necessary, the cost of which is estimated at $1,000,000.

SOUTHERN.

Big Stone Gap, Va.—Works are being built with the Glamorgan Co., Lynchburg, as contractors.

Eagle Rock, Va.—The Craig Valley Co. has been incorporated by G. K. Anderson, Henry Taylor, and others, to construct water-works, electric lights, and to deal in real estate.

Warrenton, Va.—The Glamorgan Co., Lynchburg, will finish works for the town here about Nov. 1.

Florence, Ga.—The new works have been satisfactorily tested. They cost $150,000.

Fort Valley, Ga.—The artesian well is declared a failure, owing to quicksand. It is now proposed to bond the town and build works, taking the supply from springs 1½ miles distant.

La Grange, Ga.—A bill will be introduced in the next Legislature authorizing the issuance of $50,000 for the construction of water-works. The town is said to be entirely without fire protection.

Tennille, Ga.—The following is from J. C. Harman:

The town proposes to build works at an estimated cost of $7,500. The supply will be from an artesian well, by pumping. The bonds have not been sold. Population, 1,000.

Tampa, Fla.—It is reported that the South Florida R. R. Co. is building works at a cost of $12,000.

Montgomery, Ala.—The City Council has appointed J. H. Turner, of Mobile, as its arbitrator, to determine the price of the Capital City Water Co.'s works. The company had not named its arbitrator at last reports.

Nashville, Tenn.—Four per cent. bonds, sufficient in amount to raise $100,000, will be hypothecated, owing to the fact that the city cannot sell the bonds at par, and is prohibited from selling them below.

Tullahoma, Tenn.—It is estimated that water-works and sewerage systems together would cost about $70,000, and an attempt to establish both will be made. Address T. J. Wilson.

Louisville, Ky.—The Court of Appeals has decided that the Louisville Water Co., whose stock is owned by the City Sinking Fund, must pay back State taxes amounting to about $75,000. The case may be carried to the United States Supreme Court. The decision is given in full in the Louisville *Courier-Journal* of Oct. 10, and the dissenting opinion of Judge W. S. Pryor in the Oct. 13 issue of the same paper.

Mount Sterling, Ky.—The following is from J. W. Hedden:

The Mt. Sterling Water-Works Co. has let the contract for constructing its works to Gardiner & McGlossan, for about $100,000. A stand pipe will be used. [The stand-pipe will be 15 × 120 ft.—ED.]

NORTH CENTRAL

Elwood, Ind.—D. H. Hick, Councilman, has sent the following:

There is talk of building works in the near future, but we cannot say how soon.

Mishawaka, Ind.—Proposals will be received until Oct. 20 for pumping machinery, and until Oct. 23 for other supplies and for labor by W. H. Dodge, President of the Mishawaka Water-works Co. The pumping machinery will consist of two 1,500,000-gall. compound condensing pumps. There will be about 19,000 ft. of 12 to 4-in. cast-iron pipe and 38 hydrants. Water will be pumped from a well 20 to 25 ft. from the pumps. The town will eventually own the works. W. B. Hosford is engineer.

New Albany, Ind.—The contract for a reservoir on Silver Hills has been awarded to D. G. Conger. It will have a capacity of 20,000,000 galls. and cost about $30,000.

Detroit, Mich.—The removal of an old reservoir now within the city has been recommended. The cost of removal is estimated at $36,600.

Essex (P. O. Windsor), Mich.—The town talks of water-works.

Belleville, Ill.—A press dispatch states that consumers have been notified by the company that water could not be furnished for several days, owing to lack of water. This is the second water famine in Belleville.

Elmhurst, Ill.—The water company has let the contract for works for $14,500. Water will be pumped from springs to a tank or tower. Thomas Bryan and H. W. King are among the directors.

Galesburg, Ill.—A new plant is being put in, with Chester B. Davis, Chicago, as Engineer. Galesburg water-works difficulties are briefly related in the *Manual of American Water-Works* for 1889-90. A company built works in 1883, previous to which the city had 1¼ miles of mains.

NORTHWESTERN.

Creston, Ia.—Construction is progressing, over 5 miles of mains having been laid.

Lexington, Neb.—The following is from a resident:

The town expects to let a contract for works on Nov. 1. Water will be pumped from a well to a stand-pipe. Estimated cost, $20,000. Bonds will be sold to raise money. Population, 1,300.

Fargo, N. Dak.—Proposals are asked by the city for $20,000 of 20-year, 5% bonds. Bids must be in by Oct. 23, and must be addressed to A. O. Rupert, City Auditor.

SOUTHWEST.

Cisco, Tex.—The Cisco Water Co. has been incorporated by T. B. Wheeler, B. W. Rose and O. T. Maxwell, with a capital of $50,000.

Eddy, Tex.—T. E. Muse informs us that works costing about $1,400 may be built. Water would be pumped from a well to a tank. Population, 350.

Flatonia, Tex.—The following is from H. N. Flato:

The town proposes to build works costing about $20,000. The source of supply has not been determined, but a stand pipe will be used. Guido Jaeger, Rich Hill, Mo., will probably be the contractor, and construction will be started as soon as possible. Population, 1,500.

Floresville, Tex.—The following is from a resident:

Works are needed and might be established by a company. Water would be pumped from the river, a mile distant. Population, 1,800.

Gainesville, Tex.—Extensions are under consideration.

Henrietta, Tex.—J. B. Hopkins, President, has sent the following:

The Henrietta Improvement Co. will begin the construction of works Nov. 1. The supply will be from wells and a creek by pumping to stand pipe. Estimated cost, $40,000. C. B. Patterson, Henrietta, is Engineer. Population, 3,000.

Laredo, Tex.—The North Laredo Land, Imigration & Water Co. has been incorporated by J. S. Taylor and others. Capital stock, $120,000. The Laredo Water Co. built works here in 1883-4.

Seymour, Tex.—Works are projected by Morgan Jones.

PACIFIC.

Woodlawn, Wash.—The village already has a pumping system of works, and construction of a reservoir for a gravity supply has just been started.

Albina, Ore.—The Albina Light & Water Co. is placing its hydrants.

Portland, Ore.—An extension of the high service system to Portland Heights is under consideration. This would probably require an additional pump.

CANADA.

Toronto, Ont.—The report of City Engineer W. T. Jennings and John Kennedy of Montreal on the causes of the late failure of the pumping engines and the future improvements needed is given in the *Toronto Globe* of Oct. 8. The failure of the engines, it is said, is due to the sand admitted to them owing to the break in the supply conduit. It is thought that the two 10,000,000-gall. pumping engines, for which bids are now being asked, will be a sufficient increase of the pumping capacity. Rather than increase the reservoir capacity the experts advise the increase, as needed, of the intake and pumping capacity.

New Westminster, B. C.—The construction of the works by the city is still being discussed. On Oct. 6 the engineer, Arthur Hill, reported to the Water Commissioners, urging immediate action. The estimated cost of the plant, as designed, is $380,000. The history of the project, which dates from 1886, is given in the *Manual of American Water-Works* for 1889-90.

ARTESIAN WELLS.

Oglethorpe, Ga.—The Town Council has decided to recase the artesian well to a depth of 400 ft.

Dallas, Tex.—The flowing artesian well recently completed for the city is so successful that there is sentiment in favor of putting down several more for a water-works supply.

Whitesborough, Tex.—It is stated that a well will be sunk.

Chamberlain, S. Dak.—The Country Commissionrs have decided to call an election to vote of $7,000 of bonds for the purchase of artesian well outfits, these to be run by the same power that is used to operate threshing machines, and the wells to be sunk after the threshing season is over.

Springfield, S. Dak.—Gray Bros., Milwaukee, Wis., will immediately begin to sink an 8-in. well, which if successful will be used to run a flour mill.

Oakes, N. Dak.—The artesian well has been completed, and has since been accepted by the Council. It is 973 ft. deep and gives a pressure of 117 lbs.

Pullman, Wash.—Water was struck at a depth of 85 ft., the boring having been through solid rock.

IRRIGATION.

Tarpon Springs, Fla.—The tarpon Springs Irrigation & Development Co. has been incorporated with a capital stock of $250,000. It will buy, build and operate water or irrigation works.

Bozeman, Mont.—Thomas Rogers is the contractor for a ditch which will take water from the West Gallatin at a point above Salesville. The total length of the ditch and branches will be 48 miles.

Powers Co., Col.—The Lamar Land & Loan Co. has bought the Black ditches. This company also controls the Lamar, Granada and State Line ditches, and will widen one of them and extend it to Battle Creek.

North Yakima, Wash.—The Northern Pacific, Yakima & Kittitas Valley Irrigating Co. will complete surveys for the Sunnyside ditch by Jan. 1, 1891. This ditch is designed to irrigate from 50,000 to 65,000 acres in Sunnyside Co., south of the North Yakima. It is expected that the ditch will be completed in a year. W. H. Hall, of San Francisco, has reported favorably upon the scheme.

SEWERAGE AND MUNICIPAL.

Sewers are proposed or ordered at Harrison, N. J.; Buffalo, N. Y.; Philadelphia, Pa.; Mt. Vernon, O.; Duluth and St. Paul, Minn.; Seymour, Ind.; Salt Lake City Utah.

Buena Vista, Va.—A long 18 in. pipe sewer has been ordered by the City Council.

Richmond, Va.—The Street Committee has under consideration a proposition from J. C. Robinson, W. P. De Saussure and others to furnish the city with a complete sewerage system.

Ridgeland, O.—At a recent town meeting Engineer Alvord explained his plans for a sewerage system, and recommended that a consulting engineer be employed to examine them. The plans were approved, and it was decided to engage an engineer.

Winnetka, Ill.—The commission appointed to prepare plans for the proposed drainage system of the town have submitted their report to the Council. Their plans involve an expense of $40,000, to be paid by special assessment.

Texarkana, Ark.—E. N. Maxwell is stated to be organizing a company to construct a sewerage system in Texarkana, Ark., and Texarkana, Tex., franchises having been obtained in both towns.

San Francisco, Cal.—The Board of Supervisors has authorized the construction of a sewer system in the Port Lobos district, in accordance with the plans and specifications of the City and County surveyors.

Spokane Falls, Wash.—The city council has ordered surveys made for a sewerage system, the estimated cost of which is $600,000.

Street improvements have been ordered in the following places: Philadelphia, Pa., grading and granite paving; Pittsburg, Pa., grading, repaving and curbing; Thomasville, Ga., gravel road making; Columbus, O., grading, curbing with Berea stone and paving with brick stone or asphalt; St. Paul, Minn., grading; Los Angeles, Cal., grading, graveling and curbing with redwood.

New York City.—Asphalt pavement on concrete foundation, granite block on concrete and asphalt on the present stone paving have been ordered on several streets.

Roanoke, Va.—The street improvements proposed here embrace $150,000 for asphalt and Belgian block pavement, and $175,000 for macadam.

Chattanooga, Tenn.—The United States Government proposes to construct and keep in repair 2 highways leading to the Chickamauga National Military Park.

Aurora, Ill.—The city proposes to lay about 14,000 sq.

yds. of cedar block pavement. The Mayor can give further information.

Omaha, Neb.—The new viaduct is being paved with cedar blocks, cut in the shape of brick and dipped in pitch and tar before being laid. The foundation floor is of 6 in. timbers covered with 3 layers of tar paper which is coated with pitch before the blocks are laid.

Seattle, Wash.—The new city charter provides for a board of public works made up of 3 members, each drawing an annual salary of $3,000 and appointed by the Mayor.

Bonds.—*West Troy, N. Y.*—The trustees have ordered $30,000 of paving bonds to be issued.

Nashville, Tenn.—The City Council has decided to issue $75,000 of sewer bonds.

ELECTRICAL.

Electric Light.—New plants are proposed at Attica and Little Falls, N. Y.; Cramer, N. J.; Kingwood, W. Va., address C. Y. Bishop; New Castle, Va., address J. M. B. Cripps. Quitman, Ga.; Water Valley, Miss.; Plaquemine, La., address the mayor; Orlando, Fla., address the mayor.

Worcester, Mass.—The Worcester Gaslight Co. is making arrangements for a consolidation with the Electric Light Co.

Mt. Airy, N. C.—H. C. Cooper and S. T. Griffith, of Bedford City, Va.; W. Duke, of Durham, and others recently purchased 1,000 acres of land in and around Mt. Airy, and intend at a later date erecting an electric light plant, mills, etc.

Charleston, S. C.—The Charleston Light and Motor Power Co. will rebuild its present works on a larger scale and erect a new plant.

Atlanta, Ga.—H. M. Atkinson, J. H. Porter, J. L. Hopkins and others have incorporated the Atlanta Electric Illuminating Co., to erect a light and power plant. It is stated that $250,000 will be invested in the works.

Cedartown, Ga.—The Cedartown Land & Improvement Co. has decided to erect an electric light plant and construct water-works.

West Indianapolis, Ind.—The Citizen's Electric Light Co. has been incorporated with $20,000 by W. D. Ernst B. F. Graves, J. B. Wilson and others.

Jacksonville, Ill.—The Jacksonville Gas Light & Coke Co. are expending some $15,000 in improvements on their plant and propose issuing $50,000 of 5% bonds to increase their electrical equipment.

Texarkana, Ark.—The Texarkana Gas & Electric Railway Co. has purchased the electric light and gas works here. It intends adding new dynamos and other machinery.

Denver, Colo.—The Mountain Electric Co. has been incorporated with $50,000 capital stock, by C. E. Lacombe, J. W. Stearns and J. Brennan.

Greenville, Tex.—Mayor R. L. Porter will receive bids until Oct. 20, for an electric light plant of twenty-five 2,000 c. p. arc and 800 incandescent lights capacity; also wire for same.

Waxahachie, Tex.—The Waxahachie Electric Light Co. is said to have increased its capital stock in order to enlarge its plant.

Seattle, Wash.—The following bids for street lighting were recently opened. Prices are for one lamp per month and all night service:

	2,000 c. p., arc.	15 c. p. incandescent.	30 c. p. incandescent.
Home Electric Co.....	$13.50	$2.20	$3.45
Seattle Gen. Elec. Co....	12.00	2.25	3 50

Olympia, Wash.—The Olympia Light & Power Co. have made the following bid for street lighting: Lighting the city for the term of 3 or 5 years for all night service for 25 or more arc lights of 2,000 c. p. per month, $11.50, or 39 cents per night, if it is desired to save lighting on moonlight nights; for 25 or more arc lights of 1,200 c. p., per month, $9.50, or 33 cents per night; for incandescent lights of 16 c. p., the first 20 lights will be $2 each per month; 30 lights, $1.95 per month, and all additional lights $1.80, or 6 cents per light per night. The bid of the Olympia Gas & Electric Light Co. was as follows: Arc lights, 2,000 c. p., 20 lights and up to 30, $14 per month each; 30 to 40 lights, $13 each; 40 to 50 lights, $12 each; all over 50 lights, $11 each. Incandescent lights at any place on the circuit, $1.50 per light of 16 c. p. These are to be either inside or outside lights, as the city may choose, the city to pay for and maintain all globes.

The Westerland Electric Conduit Co., has been incorporated at Atlanta, Ga., with J. A. Stephens as President and J. W. James as Secretary. The capital stock has been fixed at $600,000. The company controll the Westerland patents for underground wire service in connection with railway propulsion and already have a number of orders for conduits.

CONTRACTING.

Paving.—*Baltimore, Md.*—Seven bids for granolithic pavement, ranging from $1.58 to $2.50 per sq. yd., were recently received.

Key West, Fla.—W. S. Walker and H. Kendrick, of Tampa, have received a paving contract amounting to between $150,000 and $200,000.

Topeka, Kan.—James Ramsey has received a contract for furnishing and laying 11,128 sq. yds. of brick pavement at $2.78 per sq. yd.

San Antonio, Tex.—The total expenditure for street improvements in the last six months has been $87,500.

Sewers.—*Troy, N. Y.*—Seery & Anderson have been awarded two contracts for 27 × 40 in. brick sewers at $3.90 and $4.57 per ft. respectively.

Baltimore, Md.—Contracts for sewer materials were recently let at the following figures: Broken stone, $1.59 per cu. yd.; sand, .68 cts. per cu. yd., vitrified blocks $108.75 per M.; hand made brick, $8.25 per M.; Round Top cement, $1.12 per bbl.; Portland, $2.90 per bbl.; Rosendale, $1.19 per bbl., Cumberland, $1.12 per bbl.

Street Lighting.—The following prices are paid for street lighting in New York State using 2,000 c. p. arc lights: Albany, 50 cts. per night: Binghamton, 35 cts.; Buffalo, 40 cts.; Oswego, 27.3 cts.; Rome 33 cts.; Troy, 29.5 cts.; Syracuse, 40 cts.

Levee Work.—*New Orleans, La.*—The following bids for levee work have been opened:

Pointe-a-la-Hache levee, in Plaquemines parish; about 15,000 cu. yds.: M. Head, 17½ cts.; Jos. Nogas, 15 cts. The latter bid is recommended.

Riceland levee, in Plaquemines parish; about 1,700 yds.; Martin Head, 18½ cts.

Guyat settlement, in Plaquemines parish; about 2,000 yds.; M. Head, 17 95-100 cts.

Tropical Bend, in Plaquemines parish; about 10,000 yds.; Martin Head, 18½ cts.; J. B. Fasterling, 18 cts.

Upper Buras, in Plaquemines parish; about 10,000 yds.; J. W. Fasting, 16¾ cts.

Lower Buras, in Plaquemines parish; about 25,000 yds.; McNamara & Wilson, 20 cts.

Canal Work.—*Albany, N. Y.*—The following bids were recently received for improving the Champlain Canal and Hudson River basin: Dredging in Albany basin, 12, 12 8 9 and 20 cts. per cu. yd. The lowest bids on the canal improvements were: 3,900 lin. ft. of work, Cuningham & Riley, $29,389; 1,400 ft. J. W. Whalen, $5,709; 1,770 ft., J. W. Whalen, $10,144; 3,200 ft., Gordon & Dardis, $18,022; 1,500 ft., J. W. Whalen, $5,112.

PROPOSALS OPEN.

Street Work.—*New York City.*—Grading and paving with granite. Public Park Dep't., Oct. 22. Grading, asphalt and granite paving and flagging. T. F. Gilroy, Oct. 23.

Newark, N. J.—Grading and paving with cobble-stone, granite and trap rock. Street Commissioner, Oct. 22.

St. Paul, Minn.—Grading and paving on a number of Streets R. L. Gorman, Oct. 20 and 21.

Sewers.—*Brooklyn, N. Y.*—J. P. Adams. Oct. 21.

New York City.—Pipe sewers. Public Parks Dep't., Oct. 22. T. F. Gilroy, Oct. 23.

Syracuse, N. Y.—Pipe sewer, 15-in. City Engineer, Oct. 31.

Bonds.—*Columbus, O.*—$211,000 of street improvement bonds, H. E. Bryan, City Clerk, Oct. 24.

Dredging.—*New York City.*—Removing rocks in Hudson River, 5 miles below Albany. Lieut. Col. G. L. Gillespie, Army Building, Oct. 30.

Granite.—*New York City.*—About 21,240 cu. ft. of headers, stretchers and coping stones for river walls, and 15,000 paving blocks. Dock Dep't, Oct. 29.

MANUFACTURING AND TECHNICAL.

Cars.—The East Tennessee, Virginia & Georgia Ry. recently placed orders for 500 coal and 300 box cars, making about 3,000 cars ordered since Jan. 1. The total car equipment added to the Northern Pacific R. R. since the beginning of the year is said to be 1,500 box, 300 coal, 860 flat, 100 refrigerator, 25 passenger, 10 baggage, 10 vestibule dining and 50 caboose cars.

The Sheffield, Ala., Car Works, of the Memphis & Charleston R. R., will soon be completed. The greater part of the company's work at Memphis and Huntsville will be done hereafter at Sheffield, and it is expected that from 200 to 300 men will be employed.

Ryan & McDonald, Waterloo, N. Y., have received a contract for 60 dump cars for a new railroad out of Denver, Colo.

Crown water meter records, kept at the Little Falls, N. Y., water works, show that under a steady pressure of 140 lbs. per sq. in. a 2 in. meter registered 3,887,892 cu. ft. from April to October, 1890, and a 3-in. meter registered 4,630,010 cu. ft. from July to October, 1890.

The North American Construction Co., Buffalo, N. Y., has just completed a 500 incandescent electric light plant at Tonawanda, N. Y., and a 750 incandescent and 60 arc light plant at Albion, N. Y. W. L. Adams is the general manager.

The Buffalo Engineering Co., 228 Pearl St., Buffalo, N. Y., is prepared to execute a general engineering and contracting business. The officers are: Charles M. Morse, M. Am. Soc. M. E., and Samuel E. Ames.

The Indianapolis Car & Manufacturing Co., has been placed in the hands of a receiver. The cause of the trouble is the failure of the Empire Lumber Co., an Alabama firm, to meet its notes, many of which were indorsed by the Indianapolis Co. There are orders on file for 1,000 cars, and it is probable that the trouble will only be temporary.

Price & Adams' Locomotive Works, in West Nashville, Tenn., were recently destroyed by fire.

The Gould Coupler Co. has removed its main office from Buffalo, N. Y., to the Equitable Building, New York City.

The Martin car-heating system has been supplied, it is said, to all the first class passenger coaches on the West Shore and New York Central roads. The trials of the system last winter were so successful that the companies decided to use it on the first class cars.

The Phœnix Foundry & Machine Co., Syracuse, N. Y., have a number of large orders on hand; among them two 80-HP. boilers and a 75 × 25 ft. stand pipe.

The Congdon Brake-Shoe Co., of Chicago, has been overcrowded with orders since June 1, and an enlargement of its works has been decided upon. An addition to the foundry, 105 × 25 ft., will at once be made. Mr. W. D. Sargent, mechanical superintendent of the company, is also making the plans for a new pattern-room which will be separated from the main building and will be equipped with the very best tools. Mr. White, recently chief pattern maker and chief draughtsman for the Ohio Falls Car Co. has taken a similar position with this company.

New Companies.—Cushing Draw-Bar Stop Co., Chicago, Ill.; capital stock, $50,000; incorporators, G. W. Cushing, C. H. Sargent, W. S. Brewster. Alton, Ill., Consolidated Electric Railway Co.; capital stock, $200,000; incorporators, C. H. Holmes, W. S. Rogers, J. Morrison. Bedford, Ind., Electric Light Co.; capital stock, $30,000; incorporators, J. F. Thornton, A. H. Davis, and others. Centralia & Central City Street Ry. Co., Centralia, Ill.; capital stock, $10,000; incorporators, S. H. Pierce, T. T. Meagher, M. P. Duncan.

The Hyatt Water Filters at Atlanta, have most successfully removed all trace of the cotton seed oil and caustic soda lately added to the supply by the burning of some oil mills and referred to by this journal. Prof. McCandless has just reported to the Board of Health that while the water in the pond is impure, owing to the causes stated, his tests show that the filtered water is all right, and that all decomposed organic matter is thus removed. An excess of alum is being used just now and this causes some alarm from the appearance of a thin film of oxide of iron dissolved from the mains. Prof. McCandless says that this is harmless and that the citizens are being provided with a good mineral water for the time being.

The Hegeman-Oliphant Filter Co., the incorporation of which was lately noted, has elected the following officers: President, Robert Hay; Vice-President, Wm. Oliphant; Secretary and Treasurer, M. M. Moore. The Executive Committee is Chauncy M. Depew, Robt. Hay and Wm. Oliphant. The main office is at 176 Montgomery St., Jersey City, and the business office is at 112 Liberty St., New York.

The Snow Steam Pump Works, of Buffalo, N. Y., have recently finished the construction of a complete plant, including a foundry, 150 × 70 ft., and a machine shop, 100 × 50 ft., for the manufacture of high grade pumping engines for all purposes. The works are located on Roesser and Snow avenues, East Buffalo. The company also has an office in the Coal & Iron Exchange Building, Buffalo. The officers are: President, D. O. Day; Vice-President, J. H. Snow; Secretary, C. O. Day; Treasurer, A. D. Bissell; Superintendent, A. C. Christensen; Manager, A. L. Ellis. Mr. Christensen was connected with Henry R. Worthington, of New York, for 12 years, and, until recently, had an office in New York as a consulting engineer. They are now building a 1,000,000 gall. engine for the Genesee Building, a 750,000-gall. duplex engine for the new Masonic Building, Buffalo, and are to furnish a complete plant for parties in Fairfield, Conn. All of their machinery is of the most improved pattern.

Metal Market Prices.—*Rails*—New York: $30; $25 to $26 for old iron rails. Chicago: $32 to $32.50; old rails, $26.75 to $27.25 for iron, $22 for steel. Pittsburg: $30 to $31; old rails, $27.75 to $28 for iron; $20 to $21 for steel.

Foundry Pig-iron.—Chicago: $15 to $17. Pittsburg: $15.50 to $17.50. New York: $16 to $18.

Track Materials.—New York: steel angle bars, $1.80 to $1.95; spikes, $2.20 to $2.25; track bolts, 2.95 to 3.10 cts. with square, and 3.10 to 3.15 cts. with hexagon nuts. Pittsburg: splice bars, 1.95 to 2.05 cts. for iron, 2 to 2.1 cts. for steel; spikes, 2.2 cts.; track bolts, 2.9 with square, and 3 cts. with hexagon nuts. Chicago: splice bars, 2.25 to 2.3 cts. for steel, and 2.1 to 2.2 cts. for iron; spikes, 2.2 to 2.25 cts; iron track bolts $3.10 to $3.15 with hexagon nuts.

Pipe.—Cast-iron, $27 to $30 per ton. Wrought iron, discounts as follows: 47½ and 40 per cent. on black and galvanized butt-welded; 60 and 47½ on black and galvanized lap-welded. Casing, 50 per cent.

Lead.—Chicago, 5.3 to 5.35 cts. New York, 5.55 to 5.75 cts.

Structural Material.—Pittsburg; angles, 2.3 cts.; tees, 2.35 cts.; beams and channels, 3.1 cts.; sheared steel bridge plates, 2.65 to 2.7 cts.; universal mill plates, 2.35 cts.; refined bars, 1.9 to 1.95 cts.; steel plates, 4.25 to 4.75 cts. for fire box; 3.1 to 3.2 cts for flange; 2.9 cts. for shell, 2.5 to 2.55 cts. for tank. New York: beams, 3.10 cts.; plates, 2.25 cts.; angles, 2.1 to 2.25 cts.; tees, 2.6 to 2.7 cts.; channels, 3.1 cts. Chicago: angle, 2.35 to 2.4 cts.; tees, 2.9 to 3.0 cts. beams, 3.2 cts.; universal plates, 2.45 to 2.55 cts.; sheared plates, iron, 2.5 to 2.6 cts.; steel, 2.6 to 2.7 cts.

Van Wert, O., Water-Works.

Sealed Proposals will be received until noon of Thursday, Oct. 30, 1890, by the Board of Water-Works of Van Wert, O., for the following items for the Van Wert Water-Works:

One thousand six hundred and fourteen (1,614) tons of cast iron water pipe, ranging from four (4) to sixteen (16) ins. diameter.

Eighty-two thousand three hundred and twenty-five (82,325) lbs. of special castings for above pipe.

Eighty-one (81) six (6) in. double nozzle fire hydrants and sixty-six (63) four (4) in. double nozzle fire hydrants.

One hundred and twelve (112) stop valves, from four (4) to sixteen (16 ins diameter, and one hundred and twelve (112) stop boxes for above valves.

Laying of above pipe and setting of above special castings, fire hydrants, stop valves and stop boxes.

One brick pumping station and one brick chimney.

Trenching and all labor and materials for the connecting together of a system of drilled six (6) in. wells.

Two (2) compound condensing duplex direct-acting pumping engines, each of one million five hundred thousand (1,500,000) galls. daily capacity, together with two (2) return tubular boilers and all appurtenances necessary to complete said machinery.

One (1) earthen reservoir of three million 3,000,000) galls. nominal capacity.

Proposals must be made on the blank forms furnished by the Board of Water-Works, and all legal formalities must be complied with to secure consideration of the proposals.

The preliminary bonds and date of furnishing materials and completion of work must be filed to constitute a formal proposal.

Plans for above work may be examined and blank form of proposal and specifications can be obtained at the office of the Board of Water-Works, Van Wert, O., or the office of the Engineer, rooms 21-22, Glenn Building, Cincinnati, O.

The proposals must be sealed and addressed to the Board of Water Works, Van Wert, O., and be indorsed with the name of the person, firm or corporation which makes the tender.

And be accompanied with a certified check payable to the order of the Board of Water-Works, as follows:

Water pipe and special castings	$500
Fire hydrants	300
Stop valves	200
Pipe laying	400
Pumping station and chimney	300
Connection of drilled wells	300
Pumping machinery	500
Reservoir	300

The Board of Water Works reserve the right to reject any or all proposals.

O. A. BALYEAT,
A. B. GLEASON,
W. C. BROOKS,
H. BUTLER,
W. B. JONES,
} Board of Water-Works.

JOHN W. HILL, Consulting and Constructing Engineer, Cincinnati, O.

VAN WERT, O., Oct. 3, 1890. 42 2t

Galt Water-Works.

NOTICE TO CONTRACTORS.

Sealed tenders will be received by I. G. Dykes, Town Clerk of Galt, Ontario, Canada, until 12 o'clock noon on Monday, the 17th day of November, A. D. 1890, to be endorsed "Tender for Water-Works."

Tender A.—For the construction of a complete system of Water-Works for said town.

Tender B.—For the construction and collecting galleries, conduit, pump well with accessories.

Tender C.—For the construction of all works not included in Tender B.

For blank forms of tender, instructions to bidders and other information apply to I. G. Dykes, Town Clerk.

Plans and specifications, forms of contract, etc., may be seen on and after Oct. 13, 1890, at the office of the Town Clerk and at the office of the Chief Engineer, 103 Bay St., Toronto

I. G. DYKES, Town Clerk.
WILLIS CHIPMAN, Chief Engineer.

Galt, October, 1890. 42-2t

Proposals for Water-Works and Bonds.

The City of Hebron, Nebraska, offers $25,000 5-.0 5% semi-annual interest water bonds. Sealed bids will be received up to Nov. 3, 8 P.M.

Also receive bids for construction of works up to Oct. 27.

F. C. HENSEL, City Clerk.

42-2t

S. E. NOBLE, Prest. JNO. E. WARE, Secy. and Treas. R. F. CARTER, Supt.

The Anniston Pipe Works,

MANUFACTURERS OF

CAST IRON WATER AND GAS PIPE,

ANNISTON, - - - - ALA.

Especially adapted for the Elevation of Clear, Gritty, Thick, or Acidulous Liquids, Quickly, Cheaply and Efficiently

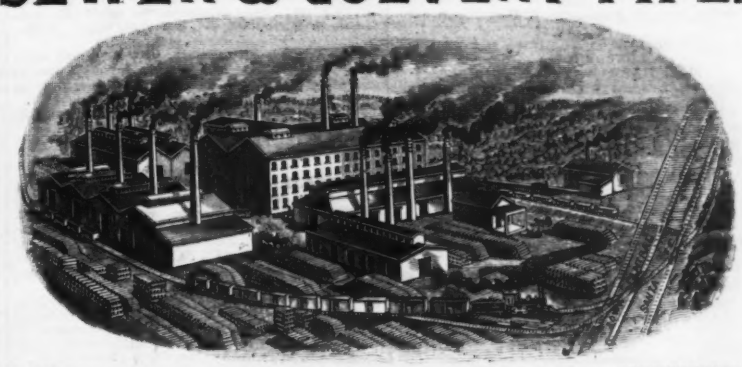
THE NEW PULSOMETER STEAM PUMP.

without Engine, Machinery, Oil, Expensive Power, Skilled Labor, or Material Wear. Send for Illustrated Catalogue.

PATENTED U. S. AND CANADA.

PULSOMETER STEAM PUMP CO., 120 Liberty St., New York.

DOUBLE STRENGTH SEWER & CULVERT PIPE.



MONMOUTH MINING & MFG. CO., MONMOUTH, ILL.

Madison, Ind., Water-Works.

Sealed Proposals will be received until noon of Monday, Oct. 27, 1890, by the Trustees of Water-Works of Madison, Ind., for the following item for the Madison Water-Works:

One circular brick Infiltration Well.

Proposals must be made on the blank forms furnished by the Trustees of Water-Works and all legal formalities must be complied with to secure consideration of proposals.

Plans for above work may be examined, and blank forms of proposal and specifications can be obtained at the office of the Trustees of Water-Works, Madison, Ind., or the office of the Engineer, rooms 21-22 Glenn Building, Cincinnati, O.

The proposals must be sealed and addressed to the Trustees of Water-Works, Madison, Ind., and be endorsed with the name of the person, firm or corporation which makes the tender, and be accompanied by a certified check, payable to the Treasurer of the Trustees of Water-Works, for $300.

The Trustees reserve the right to reject any or all proposals.

W. W. HINDS,
JNO. C. ROBERTS,
E. J. COLLINS,
} The Trustees of Water-Works.

JNO. W. HILL, Consulting Engineer, Cincinnati, O.

MADISON, Ind., Oct. 9, 1890. 42-1t

Ore Dock.

OFFICE OF IRON RANGE & HURON BAY R. R. CO., ARVON, Mich., Oct. 8, 1890.

Proposals will be received at this office for the furnishing of the labor and material for the construction of an Ore Dock for the Iron Range & Huron Bay R. R. Co. on Huron Bay, Lake Superior, Baraga county, Mich., until 12 o'clock noon, Nov. 1, 1890.

There will be about 2,000,000 ft. B. M. of timber and 3,000 piles.

Plans and specifications can be seen at this office.

The right to reject any or all bids is reserved.

MILO DAVIS, Chief Engineer, Arvon, Baraga Co., Mich.

42-2t

Artesian Well.

OFFICE OF THE CITY OF CHARLESTON WATER-WORKS CO., GEORGE ST., CHARLESTON S. C., Oct. 13, 1890.

Proposals are invited for sinking an artesian well in the city of Charleston, S. C.

The depth of the well to be not less than 2,000 ft., with a minimum diameter of 6 in. at the maximum depth.

All proposals must be forwarded by the first day of December next.

Full particulars will be furnished on application to the undersigned.

ZIMMERMAN DAVIS, Secretary and Treasurer.

42-7t

U. S. ENGINEER OFFICE, Charleston-Kanawha, W. Va., Sept. 29, 1890. Proposals for building the foundations and the pier, abutment, etc., for a movable dam at lock No. 7 of the Great Kanawha River improvement will be received at this office until 3 P. M. of Dec. 3, 1890, and then opened. The attention of bidders is called to the acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 332, and Vol 24, page 414, Statutes at Large. Information can be obtained by application to Addison M. Scott, Resident Engineer. WM. P. CRAIGHILL, Colonel of Engineers, U. S. A. 42-4t

U. S. ENGINEER OFFICE, St. Augustine, Fla., Oct. 15, 1890.—Sealed proposals, in triplicate, for furnishing materials and constructing jetties at the mouth of St. John's River, Fla., will be received at this office until 12 o clock, noon, standard time, on Nov. 15, 1890, and then be opened immediately. For all information apply to this office. The attention of bidders is invited to the Acts of Congress approved Feb. 26, 1885, and Feb 23, 1887, Vol. 23, p. 332, and Vol. 24, p. 414, Statutes at Large. W. M. BLACK, Captain Corps of Engineers, U. S. A. 42-4t

U. S. ENGINEER OFFICE, CLEVELAND, O., Oct. 11, 1890.—Sealed proposals in duplicate will be received at this office until 12 o'clock M., Monday, Oct. 27, 1890, and then opened, for dredging at the following localities: At Toledo Harbor, O.; at Port Clinton Harbor, O.; at Sandusky Harbor, O.; at Huron Harbor, O.; at Black River Harbor, O.; at Cleveland Harbor, O.; at Fairport Harbor, O.; at Ashtabula Harbor, O., and from Sandusky River O. All information can be obtained at this office. The United States reserves the right to reject any or all proposals. Preference will be given to materials and plant of domestic production or manufacture, conditions of quality and price (import duties included) being equal. The attention of bidders is invited to the Acts of Congress approved Feb. 26, 1885, and Feb 23, 1887, vol. 23, page 332, and vol. 24, page 414, Statutes at Large. L. COOPER OVERMAN, Major of Engineers. 42-2t

Proposals for Water-Works Material for Remodeling, Enlarging and Extending the San Angelo Water-Works.

SAN ANGELO, Texas, Oct. 10, 1890.

Sealed proposals will be received at this office until 12 M. Monday, Nov. 10 proximo, to furnish and deliver at R. R. Depot, this city, 400 (four hundred) lineal feet 12-in., 5,800 (five thousand eight hundred) lineal feet 10-in., 5,100 (five thousand one hundred) lineal feet 8-in., 3,200 (three thousand two hundred) lineal feet 6 in., 12,400 (twelve thousand four hundred) lineal feet 4-in., standard weight and size, cast iron water pipe for street mains, coated with Smith's patent enamel varnish coal tar, and to stand a pressure of 300 lbs. to the square inch at foundry.

20,000 (twenty thousand pounds) of special castings. (Above quantities of pipe and specials are approximate.)

14 (fourteen) valves for the street mains, ranging from 12 to 4-in.

25 (twenty-five) 2 hose-way standard size 2½-in. tip, 4-in. inlet fire hydrants, 3 ft. from pavement line to inlet.

16,000 (sixteen thousand) lbs. of soft lead.

1,100 (eleven hundred) " " yarn.

One compound duplex non-condensing steam pump; 12 and 18-in. cylinders by 10¼ water cylinders, 18-in. length of stroke so arranged as to admit live steam direct from boiler into the 18-in. cylinders for fire pressure. To be built sufficiently strong to work for direct fire pressure service to 135 lbs. water pressure.

One water-power pump; 1,000,000 galls. daily (24 hours) capacity, and capable of pumping for fire pressure against 135 lbs. water pressure.

Suction and discharge openings of above pumps to be 12 and 10 ins respectively, and fitted for the standard cast iron pipe.

One 70 HP. automatic cut off steam engine. (Bids for the pumps not to be based upon *both* pumps being take .)

One steel return tubular boiler, 52-in. diameter by 14 ft long, 56 3-in. tubes, with all fixtures complete.

Separate bids to furnish "the pipe and specials," "the valves and hydrants," "the lead and yarn," "the pumps," "the engine and boiler," will be considered. Prices to include freight charges to San Angelo. Proposals to be addressed to the undersigned, and envelopes marked "Proposals for Water-Works Material."

J. V. MILLSPAUGH, Pres. San Angelo Water Works Co.

42-2t

PROPOSALS FOR CONSTRUCTION.—U. S. Engineer Office, 80 Euclid avenue, Cleveland, O., Oct. 14, 1890. Sealed proposals, in duplicate, will be received at this office until 12 o'clock M., on Monday, the 3d day of November next, at which time they will be opened in the presence of bidders, for constructing 450 lineal feet, more or less, of the structure of east breakwater at Cleveland, O. Preference will be given to materials and plants of domestic production or manufacture, conditions of quality and price (import duties included) being equal. The attention of bidders is invited to acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, vol. 23, page 332, and vol. 24, page 414, Statutes at Large. All information can be obtained at this office. The United States reserves the right to reject any or all proposals. L. COOPER OVERMAN, Major of Engineers. 42-3t

PROPOSALS FOR DREDGING. U. S. Engineer Office, Cleveland, O., Oct. 14, 1890. Sealed proposals, in duplicate, will be received at this office until 12 o'clock M., on Monday, the 3d day of November, 1890, and then opened, for excavating 240,000 cubic yards, more or less, of material from Sandusky Bay along line of proposed straight channel for Sandusky Harbor, Ohio. Preference will be given to materials and plant of domestic production or manufacture, conditions of quality and price (import duties included) being equal. The attention of bidders is invited to acts of Congress approved Feb. 26, 1885, and Feb 23, 1887, vol. 23, page 332, and vol. 24, page 414, Statutes at Large. All information can be obtained at this office. The United States reserves the right to reject any or all proposals. L. COOPER OVERMAN, Major of Engineers. 42-3t

AT A SACRIFICE.

A complete cotton factory with latest improved machinery, with thirty acres of beautifully located land, in one of the most flourishing young cities in Southwest Texas for Sale. Land alone worth half the money. Write for particulars to

RANNEY & MONTGOMERY, Yoakum, Tex.

42-4t

(*For other Proposals See Page XXII.*)

"THE WELLS LIGHT"

WALLWORK & WELLS' PATENTS. (Registered Title.)

USES KEROSENE OIL.

Obtainable Everywhere.

ESPECIALLY ADAPTED

—FOR—

CONTRACTORS' NIGHT-WORK.

800 and 2,000 CANDLE POWER

REQUIRES NO ENGINE OR AIR COMPRESSOR to drive it as "others do."

(Copy.)
SAVANNAH, AMERICUS & MONTGOMERY RAILWAY.
OFFICE OF THE CHIEF ENGINEER,
AMERICUS, Ga., Aug. 8, 1890.
R. E. HARDAWAY, Chief Engineer.
Messrs. Keegan & Halpin, 46 Washington Street, New York City:
DEAR SIRS: I used four of your lights for steam shovel work at night some time since and they gave entire satisfaction.
Yours very truly,
B. E. HARDAWAY, C.E.

(Copy.)
WEST VIRGINIA IMPROVEMENT CO.
WESTON, W. Va., June 24, 1890.
Messrs. Keegan & Halpin, 46 Washington Street, New York:
GENTLEMEN: Replying to your favor of 21st inst., the light you sent us has thus far given satisfaction, and I can see no chance for improvement in it.
Yours truly,
J. A. FICKINGER, Ch. Eng.

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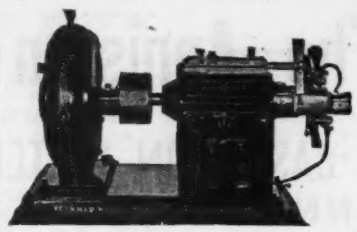

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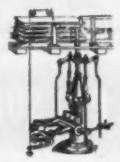

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